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SCIENTIST

RESEARCH FOR THE "CANBERRA"

by John West, Technical Adviser, P & O

WAS MAN MORE AQUATIC IN THE PAST?

by Sir Alister Hardy, FRS

**POSSIBLE USES OF MICROWAVES
IN TELECOMMUNICATION**

by William Bray, Post Office Engineering Department

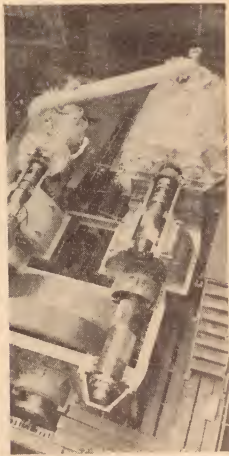
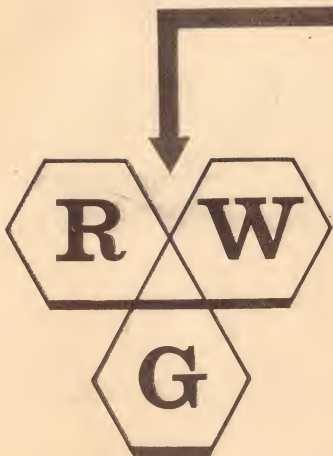
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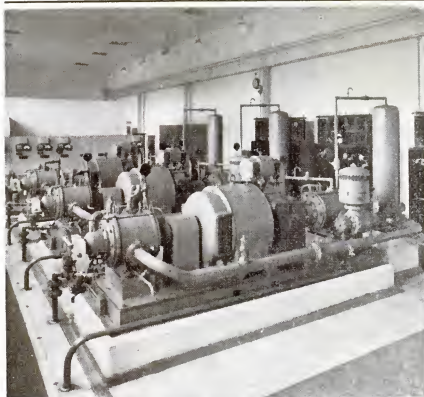
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NOTES AND COMMENTS

Pioneer V

THE new artificial planet, *Pioneer V*, launched from Cape Canaveral on 11 March and now edging eccentrically towards the orbit of Venus, is a scientific and technological experiment of unusual interest. It is a logical extension of the scientific work already carried out by the Americans with their *Explorers*, *Vanguards* and earlier *Pioneers*; at the same time, it is pioneering in a very real sense, by entering regions closer to the Sun, and being equipped with novel transmitting equipment—giving, it is hoped, the most distant point-to-point transmission ever attempted, exceeded in path length only by the American and British radio echoes from Venus itself.

The method by which communication ranges up to 50 million miles are to be achieved depends on solar cells converting the energy of the Sun's rays into electricity which can be stored in the vehicle's chemical batteries. The estimates show that the 5-watt transmitter should work, on command, for 45 minutes a day, until the range is about five million miles—that is, about three weeks from now. Then a 150-watt transmitter will take over and operate for a few minutes a day. The actual durations will depend upon the receiving conditions and on the state of the chemical batteries.

The main line of American research beyond the atmosphere has been concerned with the atomic radiations in space and the variations in the Sun which influence their intensities. In these studies *Pioneer V* is sure to provide important data if the instruments continue to work well. In particular it will measure the interplanetary magnetic field and may detect puffs of hot electrified gas, wrapped in magnetism, which are believed to emerge from the Sun and to wander in the Solar system. The replenishment of the Van Allen radiation girdle around the Earth is thought to depend on such puffs.

What is particularly valuable about the American programme is that the observations with *Pioneer V* can be related to concurrent measurements of radiation and magnetism nearer the Earth, particularly by *Explorer VII*, *Vanguard III* and by new satellites to be launched during the next few months. In this way parochial events—so far baffling in their complexity and variability may become explicable in terms of general changes far away in the solar system.

The Jodrell Bank radio telescope is, of course, the key to the whole experiment: without it, the experiment would necessarily be far less ambitious. The telescope is distracted from its regular astronomical work (currently an attempt is being made to detect magnetic fields in distant radio stars by their effects on the hydrogen radio emission) for only an hour or two each day. When *Pioneer V*'s signals are lost in the background radio noise it will not make a close approach to the Earth for some years, by which time the Americans will have a big steerable radio telescope of their own.



Dr. Bhabha's
atomic trump

LOOK for rapid developments this summer in India's plan for a 250-megawatt nuclear power station in the Bombay area. This has long been the ambition of India's irrepresible Dr. Bhabha, head of the country's Atomic Energy Commission, but India has never had enough money to pay for the project. A nuclear power station of this size would cost in the region of £30 million. The Western countries have advanced India huge sums to help industrialize the country, but have so far always drawn the line at atomic power.

Now the situation has changed. Russian atomic scientists led by Professor Emelyanov have been on an official visit to India and last week the two countries agreed to co-operate—in the now classic phrase—"on the peaceful uses of atomic energy", including the design and construction of nuclear power stations. Professor Emelyanov said that Russia would be glad to build India a nuclear power station in the Bombay area, adding mischievously that Russia was the only country that attached no strings to the sale of nuclear power plants. Was he hinting here that Russia would have no objection to India's making atomic weapons out of plutonium produced in such a power station if rumours about China's impending nuclear test turn out after all to be true?

Whatever he meant, Professor Emelyanov's progress in India has been closely followed in the West. If Dr. Bhabha says now that he would like to order a nuclear power station from Britain or the United States, neither Government is likely to refuse

NOTES AND COMMENTS *continued*

to lend him the money to pay for it, for fear of being outbid by the Soviet Union.

All of this is encouraging news to British industry, which has been discussing the possibility of building such a power station in India for the best part of 18 months knowing all the time that such talks were useless until means could be found of overcoming the financial difficulties, for it was quite plain that India would never be able to pay for it herself. Associated Electrical Industries and English Electric are the most anxious to win the order, but a team from General Electric is leaving for India at the end of the month—again to discuss the financial, not the technical, aspects of the deal. Meanwhile a delegation from the American Atomic Energy Commission is already in India.

Dr. Bhabha has always argued that India needs atomic power urgently because of the vast distances of some of the biggest industrial centres from the coalfields; in some cases coal has to be hauled 700, and in other cases 1,500 miles from the mines to the factories. The cost of doing this and the railway rolling stock it needs more than offsets, in his view, the higher capital cost of atomic power. He can never have expected to convert Western Governments to his point of view with quite such speed.

Revolution in the techs

THE White Paper on technical education in December, 1956, was intended to bring the technical colleges of Great Britain up to date. Thanks to the enthusiasm of some authorities it has done more than that; it has precipitated what is likely to be a complete revolution in technical education. Last week's policy statement—*The Government of Technical Colleges*—by the Federation of British Industries gives an admirable account of organization and the progress being made, but the recommendations it contains hardly qualify it as the handbook for this particular revolution.

In technical education two major changes now seem inevitable. The first is that academic standards will be raised until the technical colleges are on a par with the universities. Secondly, the new college buildings will have very much greater provision



for resident students. There will be nothing to distinguish the Loughborough College of Technology, for example, from any other university, except that it will have better facilities than most. The Northern Polytechnic in London and the Harris College of Further Education at Preston are among the host of others to be transformed.

The concept of the worthy mechanic studying outside working hours and attending evening classes is dying rapidly. He is being replaced at all stages by the student of technology on a sandwich course and more and more by the full-time residential student—the technological undergraduate.

The technical college, unlike the ordinary university, needs to keep in due touch with local industry. The Minister of Education has suggested that half the college governors should be from industry, the other half from the local education authority. The FBI endorses this and other Ministerial recommendations, but adds an ominous sentence, "Governors representing industry and commerce should insist that the powers with which they are endowed are commensurate with the responsibilities they are asked to assume".

Since these responsibilities include the finance of the college and the appointment of teaching and non-teaching staff, it could be argued that they are very great indeed. Although the Minister suggested that the formation of educational policy should be left to the college staff, it is not difficult to envisage a situation in which the industrial governors and the industrialist members of the local authority could constitute such a majority as to make it difficult to resist their views. The interest of local industry in its technical college is of paramount importance, but the say of the principal and his staff in the policies of their college should depend on something more substantial than the strength of their personalities.

The millions of survivors?

A FAMILIAR Civil Defence poster shows a group of people apparently looking—unwisely—at a nuclear fireball, and asks, "The H-Bomb: what about the millions of survivors?" Commenting on the failure of London Civil Defence authorities to recruit anything like the full peacetime establishment of volunteers, *The Times* has pointed out that the common feeling seems to be that total nuclear war would virtually annihilate this country. In so doing, it has renewed the controversy between scientists as to whether or not this is true.

Thus Dr. H. W. Thompson, a physical chemist of Oxford, has reproached *The Times* for its "attitude of surrender". He asserts that scientific appraisal of such factual evidence as we possess does not predict total annihilation. He is pretty emphatic about it, but so too is Dr. P. T. Matthews, a theoretical physicist of London, who takes the opposite view.

Can one resolve the matter? It is certainly true that there would be many millions of survivors, including many whom urgent rescue and medical attention could save from death, in the "text-book" situation of an isolated H-bomb, which forms the basis of much of current Civil Defence instruction.

However, it is hard to believe in such a relatively simple situation, especially in view of the abundance of bases in England, from which it is proposed that H-bomb retaliation would be launched by rocket and bomber. To allow for misses, the "enemy" would be obliged to explode several H-bombs solely for the purpose of destroying as many Allied nuclear bombs as possible. Moreover, in a total nuclear war one would have to expect that all the major ports and naval bases would also be attacked. It would be unrealistic to expect less.

What would be the effects of such an attack? The Home Office Civil Defence manual expects that a 10-megaton weapon will produce a "Zone Z" of about 1,000 square miles from which total evacuation would be required if sickness and death were not to overtake the great majority of people. The area of England and Wales is 60,000 square miles.

So it is clear that with the numbers

NOTES AND COMMENTS *continued*

of bombs envisaged, and with the overlap of the far larger zones of lighter fall-out, the orders of magnitude are about right for turning the whole country into Zone Z. However, the outcome depends to some extent on the actual distribution of the targets, on the number of bombs per target (and hence on the accuracy of the Soviet missiles), on the wind direction and on the size and yield of fission products from each bomb. There are no grounds for hoping that "clean" bombs would be used.

Because of these uncertainties it is not possible to say categorically that there would be no English survivors of such an attack, though they would be a relatively small fraction of the population. In some regions, such as Cornwall, and in Wales and Northern Scotland the chances of survival—at any rate from the immediate consequences of the attack—might be fairly good, provided there were no nuclear bases there.

So there does remain some case for teaching civilians what to do if they find themselves in a fallout zone, because one cannot be certain in what pockets hope might not remain. However, such training would make sense only if large stores of uncontaminated food and water were available for the aftermath; otherwise one exchanges a fairly quick death for a slow one.

The small expenditure on Civil Defence (£7½ million in the coming year) has been assumed by some to indicate that the Government does not really take it seriously. It is certainly to be doubted whether present Civil Defence arrangements are based on a realistic understanding of the widespread consequences of a nuclear disaster.

Mark of the railway companies

IF rail transport is to be given the long promised "new look", the rationalization of its scattered research activities is essential. An important step in this direction took place last week when Sir Brian Robertson, Chairman of the British Transport Commission, opened a handsome new research centre on the site of the former Alexandra Palace station in North London.

The new centre brings under one



roof research and testing on building materials and corrosion which has in the past been carried out at a number of different laboratories. Much of the work is routine testing of new building materials offered by manufacturers. The laboratory will also try to find new ways of repairing existing structures—for example, by the reinforcement of decayed brickwork. In addition some original research will be undertaken. One of the current projects is the formulation of an expanding cement to counteract settlement.

The feature of the new laboratory is that it is a national centre for the whole railway network. Only the chemical section, which shares the same buildings, will retain the old area laboratory pattern—a system of subdivision which is the British Transport Commission's legacy from the former railway companies. The old railway companies had a fiercely independent spirit, and always sought to build their own laboratories, factories, engineering shops and even water supplies. Between Watford and Euston, for instance, all railway premises draw water from a private supply, ignoring the public supply alongside. All over the country there are isolated cottages and other buildings which British Railways took over complete with their own private water supply system—a costly service to maintain.

To look after these small private supply systems technical staff scurry about the countryside sampling water that cannot be pronounced fit to drink until subjected to bacteriological analysis in the appropriate regional laboratory.

The same problems occur throughout the railway system. The research laboratories are almost as fragmented as the water supplies. Fortunately, the strength of railway traditions is at least beginning to weaken and the BTC is making some efforts to coordinate and expand railway research.

New way of diagnosing leukaemia?

LEUKAEMIA is one of the fatal blood diseases. A patient with this illness loses control over the production of white blood cells in the bone marrow and an excessive number appear in the blood at the expense of the red cells. Fortunately rare, the condition is particularly distressing because young children are among its victims. The evidence that ionizing radiations may induce leukaemia in Man is now convincing, and since the advent of the atom bomb there has been an increase in its incidence, particularly in younger persons.

There is no cure for leukaemia. There are only palliative drugs such as the corticosteroids, antimetabolites like mercaptopurine or amethopterin and tumour-inhibiting drugs such as busulphan. Life is prolonged by ringing the changes on these. Treatment might be more effective if an earlier diagnosis could be made. There are no signs or symptoms characteristic of leukaemia, which is often not diagnosed clinically but in the laboratory, from a blood film, when the disease is well advanced. A possible lead in the earlier diagnosis of the disease is the discovery by A. J. Hale and Sylvia Wilson, of the Institute of Physiology, Glasgow University, that the pattern of distribution of desoxyribonucleic acid (DNA) in the nuclei of marrow and lymph gland cells of some cases of leukaemia is similar to that in the nuclei of the cells of many cancers. A preliminary note on the work is contained in the current issue of *The Lancet*.

The DNA content of the resting nuclei of cells of all the tissues of any one species is a constant related to the number of chromosomes in these cells. If the nuclei are not resting, but are actively synthesizing DNA, as in cancer and leukaemia cells, they contain an increased amount of this substance. Special techniques are necessary to determine the amount of DNA in a cell. It is stained by what is known as the Feulgen process, and the amount of DNA estimated from the density of the colour produced. The abnormal DNA pattern was found in the nuclei of bone marrow and lymph gland cells, but not in those of cells of the circulating blood.

Hale and Miss Wilson are trying to correlate the DNA changes in the

NOTES AND COMMENTS *continued*

marrow cell nuclei and the progress of the leukaemia. It is possible that here they have a method for the early detection of the disease before the affected cells flood the blood stream, and before the condition gives rise to symptoms.

Putting up with the press

JOURNALISTS who attend press conferences regularly have sometimes suspected that there are certain little-known laws which cover the hospitality that often accompanies them. One is that the number of column-inches of editorial matter expected varies directly with the number of square inches of smoked salmon consumed. Another, better-founded one, is that the quantity of refreshment provided is in inverse proportion to the news value of the subject of the press conference.

Not the least valuable aspect of the excellent *A Guide to Press Relations for Scientific, Medical and Technical Conferences*, which has been prepared by the Association of British Science Writers and published by the British Association, is that it stresses that there is no substitute for news. The pamphlet is edited by a well-known science reporter and secretary of the Science Writers' Association, Ronald Bedford. The *Guide* is full of practical suggestions for making sure that news which should be communicated to the press is not missed because of any failure in the press arrangements at a conference.

The booklet will make anyone who undertakes to serve as press officer at a conference realize what a big task he may be tackling. He may have to assist reporters from news agencies, wireless and television, morning, evening and local newspapers, technical journals and the foreign press, as well as freelance journalists—all of whom are likely to have different needs. In addition, he will have to ensure that the speakers and participants at the conference give the press the help to which they are entitled. Moreover, he must see that where necessary efficient summaries and photographs are prepared and made available in good time.

But though the *Guide* shows the considerable extent of the work which may face a press officer, it also gives



him great assistance in setting about it. Only one footnote might be added. The *Guide* very rightly says that press conferences should not be allowed to go on too long, and that press officers must prevent individual journalists from "hogging" them; it might have added a specific caveat against the reverse of this—the occasional tendency to say "Shall we continue the discussion in an informal way; I know you all want some refreshment" as soon as a tricky point has been reached. Two good rules for those giving press conferences are: don't give one unless you are prepared to say quite a bit, and be quite frank if there is some information which you are not prepared to give—a journalist can usually guess if you are trying to hold something back.

The pamphlet costs 3s. in an interleaved version, which allows space for notes or amendments, and 2s. for the plain version. It can be obtained from the British Association, 18 Adam Street, London, WC2; postage costs 6d. extra.

American science trip for young people

LAST summer, Worldfriends—an organization devoted to promoting international friendship—held in London its first International Youth Science Fortnight, in conjunction with the British Association. Worldfriends' main means of operation is through exchange visits. Two hundred and fifty boys and girls of between 15 and 19 came from Western Europe to take part in the Fortnight, which included a

programme of lectures and visits to places of scientific interest. Since then, last year's guests have been hosts on the Continent to the British boys and girls with whom they stayed.

This year Worldfriends is launching an even more ambitious project—an Anglo-American exchange. Once again the principle that a common interest is the best basis for friendship is being adopted, and science is serving as the link. For a cost of £112, which includes everything except pocket money, 50 or more boys and girls of 15 to 19 will be flown to America and given about four weeks of lectures and visits. They will stay with families found by the Rotary Club of Jenkintown, a suburb of Philadelphia. Then, in the summer of 1961, their parents will provide similar hospitality for American guests.

The scheme is conditional on not fewer than 50 applicants coming forward and being selected by Lord Luke, the Chairman of "Operation Britain". Obviously the cost of the trip will be something of a difficulty. On the other hand, chances of spending a month in America for as low a sum as that are rare, and it is also hoped that some benevolent firms or individuals may provide scholarships.

The basis of selection, apart from endorsement by headmasters or headmistresses, will be the submission of an essay of not more than 800 words: the subject will be *Portrait of a Scientist in 1970*. The entrants need not necessarily be science specialists. The essays have to be submitted by Good Friday, 15 April, 1960, to Lord Luke at Worldfriends, 308 Earls Court Road, London, SW5, from which address application forms can also be obtained.

The beginning of it all

WHEN does a human life begin? That is a question upon which a biologist might pronounce a simple answer: at the mustering of the chromosomes; or a quite different, less simple answer. It is a loaded question. When does the soul enter the body?

The British Council of Churches has a working party studying such questions from medical and theological viewpoints. Its conclusions will have an important bearing on the research directed towards the discovery of a means of damping the world



NOTES AND COMMENTS *continued*

population explosion on a world-wide basis. For the scientist has to recognize that whatever means of birth control he may devise has to win a place for itself within the matrix of moral, religious and political codes. Technical detail here touches upon the sanctity of human life.

Among volunteers in Britain, there have begun small-scale clinical trials of pills which, taken by mouth, prevent ovulation. These are synthetic steroids, chemically related to the natural progesterone hormone that prevents ovulation during pregnancy. The same drugs can serve to treat cases of infertility, by resting the reproductive system for a while.

The pills have been tried in Puerto Rico, Mexico and the United States, with reasonable success. However, the British experiments, planned by the Council for the Investigation of Fertility Control, are not expected to lead to any general application of the technique. Their aim is twofold: to keep workers in this country abreast of the American developments and as a dress-rehearsal for the day when a more promising type of pill can be tested.

The American trials have shown that the use of these pills results in no loss in subsequent fertility; moreover—a very important point—the experts seem to agree that these artificial steroids are not carcinogenic even though the body's own steroids can be. There is some residual doubt about effects on the general balance between the glands of the body, but it is clear that over three or four years the use of these pills is harmless enough.

There are, however, big snags which make them unsuitable for world-wide use. The pills have to be taken almost daily and under strict medical supervision because of the possibility of distressing side effects. Even under trial conditions in Puerto Rico, the overall efficiency of control was only 70 per cent. because of imperfect administration. Moreover, the pills are fairly expensive.

So the search continues for a cheaper, simpler chemical that can be taken less frequently and without side-effects. Such a drug might interfere with the reproductive process in quite another way—for example, by the prevention of implantation of the fertilized egg—raising again the question, when does life begin?

Humming bird battles

KEEPERS of different species of hummingbirds know that the chief difficulty is to keep them happily apart. They are among the most pugnacious defenders of territory in the bird world. How this works out in the wild has been reported to the New York Zoological Society by Mr. Oliver Griswold, of the University of Miami, who has spent some time observing and catching one of the most spectacular-looking species, the Streamer-tail (*Trochilus polytmus*) in the humid highlands of Jamaica. In-



cluding the long tails on which they appear to stand in mid-air, Streamers are among the biggest Trochilids known. They are about ten inches long.

Griswold photographed hummingbird life in close-up by finding a nest of Streamers in a hibiscus hedge and gently tethering with a silk thread a fledgling which was about to leave home. It rose to the extent of its cord like a little helicopter every time its parents returned with food. Like dragonflies, the Streamers both patrol and defend their territory. The arrival of a stranger was enough to transfer a languidly hovering specimen into a darting and diving fury. They had a warning or battle cry, a high-pitched *tscek*, and what nobody has apparently heard before, a thin but melodious song.

Observations showed that favoured feeding territories, such as places where gnats danced between big trees in the evening, were taken up by the most aggressive birds and defended against almost all species, certainly their own kind. By day the Streamers kept to the shadows, and emerged only to sip nectar and show they were "at home" and not sociable. Battles consisted of chases and interceptions with furious wing buffetings: feathers were dislodged, but no blood seemed to be shed. Of about a dozen birds caught (with "lime") a pair were sent to one of the most distinguished British aviculturists, Mr. Richard de Quincy, of Hereford, who mated them and got

two chicks, the first to hatch in captivity. At London Zoo about eight species of Trochilids are fed on fruit-flies, small spiders, liver extract, invert sugar and vitamins. In a "mixed" aviary, each has to be given a feeding tube of its own.

Burned bones in 'e' interpreted

A STUDY on cremation by Dr. Calvin Wells is reported in *Antiquity* in connection with his researches on early human skeletons in the British Isles. Dr. Wells complains that physical anthropologists have neglected cremated remains and who can blame them, when we learn that fragments of bone from fifth- to seventh-century urns at Illington, Norfolk, were nearly all badly distorted and none more than a few centimetres long. To investigate the problem of distortion, and to discover the techniques of the funeral pyre, Dr. Wells enlisted the aid of the authorities of two modern crematoria.

The difficulties of determining the age and sex of the Illington remains were, of course, enormous. It was suspected that shrinkage of bones might lead to males being assessed as females. But in modern material the shrinkage was found to be almost negligible. The average age of death for the Illington men was estimated as thirty-three years, for the women twenty-seven years; in ancient communities, males generally seem to have outlived women, mainly no doubt because of the hazards of childbirth.

In some of the urns a "curious clinker" was found. This occurred also beneath the heads of some, but not all, of the modern cremations. It is believed to be transformed keratin from the hair and is not found in the case of bald or closely cropped males. The presence of this clinker might help to determine female remains in future.

From the relatively light firing of certain bones, it seems probable that the Illington corpses were laid on the ground and the pyre built on top. This partial burning applies in modern cremations, where the body rests on the floor and gas jets are directed on to it from above and from the sides. Bodies are cremated in just over an hour, at a temperature of about 900°C. Those which died from a

NOTES AND COMMENTS *continued*

wasting disease such as tuberculosis take rather longer since they have little fat; "large corpulent cadavers", on the other hand, burn more rapidly. The Illington urns often contain glass beads, which were partly fused though not completely liquefied. Experiments showed that the beads start to fuse at 870°C. and are completely molten at 940°C. The temperature of the pyres, therefore, must have been as great as that in modern cremation ovens.

In another connection, Dr. Wells has found what he believes to be the earliest undoubted evidence of leprosy in Britain from a sixth-century skeleton from Beckford, Gloucestershire. Since the first leper house in England is recorded in the seventh century, it is curious that the disease has never previously been detected in ancient bones in this country, as it has in Denmark. Probably the reason is that the smaller bones of the feet and hands, where the ravages of the disease are most marked, are seldom examined very carefully. It is far more difficult to distinguish the effects of leprosy in the skull. Robert the Bruce is said to have died a leper in 1329; a cast of his skull, taken when he was reburied in 1819, shows that he had lost the upper incisors and this, together with other features, has been said to confirm the cause of death. Dr. Wells, however, is not entirely convinced of this.

Cooling the brain

COOLING the body for operations on the heart is now commonplace. The object of lowering body temperature is to slow down metabolism, and hence oxygen consumption, because the brain and the heart are the first organs to suffer from oxygen lack. At body temperature they can survive for only a few minutes without it, although at 10°C. below this they can tolerate being deprived of oxygen for a much longer period. The heart does not stand hypothermia as well as the brain. At 23° to 20° C. it begins to beat irregularly and may even stop. Hence considerable care is needed in regulating the body temperature in heart operations. The brain, on the other hand, can be cooled to 15° to 20° C. for fifty minutes without injury, while the rest of the body is at about 30° C.



This enables the surgeon to do complicated operations on the brain at leisure, instead of watching the clock to see that he has not exceeded the safe period.

The brain is cooled by leading blood from the carotid artery in the neck through a cooler and back to the head by the jugular vein. The flow of cold blood through the brain slowly lowers its temperature. If a blood oxygenator and pump are incorporated in the circuit, quite long operations on the brain can be done with safety. There is a time limit because of a slow leak of blood from the brain to the general circulation. This leak can be measured by adding sodium iodide labelled with iodine-131 to the closed brain perfusion circuit, and measuring the radioactivity that escapes into the general circulation. The reduction in the metabolism of the nerve cells of the brain is shown by the electroencephalograph, which fails to record any electrical activity at 18° C.

Another possible use for perfusion of the cooled brain is the direct administration of tumour-inhibiting drugs such as triethylphosphoramide (TEPA) for the treatment of inoperable brain tumours. By isolating an organ it is possible to perfuse it with much larger quantities of these tumour-inhibiting drugs than the body as a whole will tolerate. This method has been tried in the treatment of certain brain tumours, but so far the results have been disappointing. However the method is worth pursuing as it has been used successfully in other parts of the body.

Sea otter is saved

THE *Promyshlenniki*, the gangs of Russian fur hunters from the islands in the Bering Sea, were a tough lot. They slaughtered seals; they slaughtered the sea-otter and they slaughtered Steller's sea-cow, the Arctic relative of the manatee and the dugong. The sea-cow never recovered. It was last seen alive in the early part of the last century. And there were some fears that the sea-otter was also on its last legs.

However, a recent report from the Smithsonian Institution shows that this interesting animal is now not only holding its own; it may even be extending its range.

Karl W. Kenyon, of the US Fish and Wildlife Service, says there may be as many as 30,000 in Alaskan waters and perhaps another thousand or so off the coast of California. Individuals, possibly the nuclei of breeding colonies, have been sighted off the shore line of Washington and British Columbia. This is good news for those who have clamoured loudly for its protection.

Like so many other animals, the sea-otter (*Lutra lutris*) was the victim of its attractive fur. On bleak shores men waited for weeks to take a shot at any otter that came in sight. It was amply worthwhile (if hard) labour. A single pelt brought in as much as 300 dollars.

Nominal protection started in 1911, but it has been possible to enforce it fairly vigorously only recently. It should now be possible to recolonize some of the animal's former territories, particularly as the Fish and Wildlife Service has learnt something about how it lives.

This has been accomplished on Amchitka Island in the Aleutians, a desolate rocky place which was found to be either fog-bound or swept by furious gales. Sea-otters love it. They are heavily built, slow-swimming animals which weigh about 70 lb. They eat molluscs and crustaceans, which are held and crushed by their curiously adapted cusped teeth. Females nurse their cubs by lying on their backs on the surface of the sea and holding their young between their forelegs. They are almost wholly marine creatures and eat about a quarter of their body weight daily.

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WAS MAN MORE AQUATIC IN THE PAST?

And was it in the sea that Man learned to stand erect? The author explains his hypothesis that we descend from more aquatic ape-like ancestors. He will contribute a further article—"Will Man be more aquatic in the future?"—to next week's issue

by Professor Sir ALISTER HARDY, FRS

ON 5 March I was asked to address a conference of the British Sub-Aqua Club at Brighton and chose as my theme "Aquatic Man: Past, Present and Future". I dealt little with the present, for Man's recent achievements in the underwater world were so well illustrated by other speakers and by films. I ventured to suggest a new hypothesis of Man's origin from more aquatic ape-like ancestors and then went on to discuss possible developments of the future. I did not expect the wide publicity that was given to my views in the daily press, and since such accounts could only be much abbreviated, and in some cases might be misleading, I gladly accepted the invitation of *The New Scientist* to give a fuller statement of my ideas.

I have been toying with this concept of Man's evolution for many years, but until this moment, which suddenly appeared to be an appropriate one, I had hesitated because it had seemed perhaps too fantastic; yet the more I reflected upon it, the more I came to believe it to be possible, or even likely. In this article I shall deal with this hypothesis; next week I shall treat of the future.

Man, of course, is a mammal, and all the mammals have been derived, as indeed have also the birds but by a different line of evolution, from reptile ancestors that flourished more than a hundred million years ago, when the world was populated by saurians of so many different kinds which have long since become extinct. These reptile ancestors in turn were derived from newt-like animals — amphibian creatures—which had only partially conquered the land and had to return to water to breed as do most of our salamanders and frogs of today. It is

equally certain that these earlier amphibians were evolved from fish which, like those primitive lung-fish that still survive in certain tropical swamps today, had developed lungs with which to breathe. Some of these air-breathing fish were able to climb from the water on to the land.

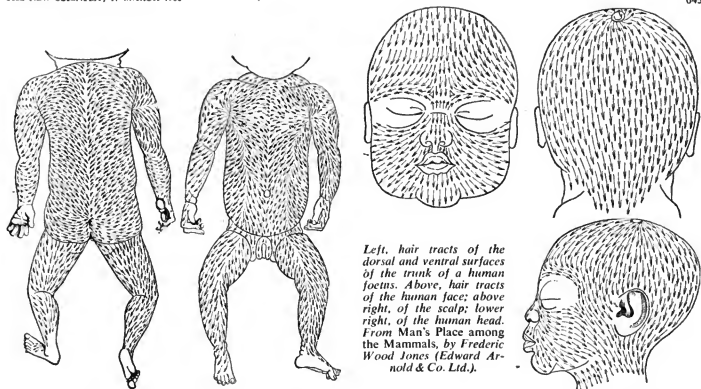
This history of the emancipation of animal life from the sea is very well known. I repeat it only because it forms the background to another story, one that is not quite so familiar to those who are not trained as zoologists. At the same time as this conquest of the land was extending with continually improving adaptations to the new terrestrial life, we see (in the fossil record) a different act repeating itself again and again, first with the amphibians, next with the reptiles, and then with the mammals and indeed the birds as well. Excessive multiplication, over-population, shortage of food, resulted in some members of each group* being forced back into the water to make a living, because there was not enough food for them on the land. Among the reptiles I need only remind you of the remarkable fish-like ichthyosaurs, of the plesiosaurs, of many marine crocodile-like animals, and of turtles, not to mention water-snakes. Then, among the mammals of today we see the great group of whales, dolphins and porpoises, with the vestigial remains of their hind legs buried deep in their bodies, beautifully adapted to marine life; or again the dugongs and manatees belonging to an entirely different group. The seals are well on their way to an almost completely aquatic life, and many other groups of mammals have aquatic representatives which

have been forced into the water in search of food: the polar bears, the otters (both freshwater and marine), various aquatic rodents, like water voles and the coypu, or insectivores like the water shrew; and, of course, we must not forget the primitive duck-billed platypus. There are, indeed, few groups that have not, during one time or another in the course of evolution, had their aquatic representatives; among the birds the penguins are supreme examples.

The suggestion I am about to make may at first seem far-fetched, yet I think it may best explain the striking physical differences that separate Man's immediate ancestors (the Hominidae) from the more ape-like forms (Pongidae) which have each diverged from a common stock of more primitive ape-like creatures which had clearly developed for a time as tree-living forms.

My thesis is that a branch of this primitive ape-stock was forced by competition from life in the trees to feed on the sea-shores and to hunt for food, shell fish, sea-urchins, etc., in the shallow waters off the coast. I suppose that they were forced into the water just as we have seen happen in so many other groups of terrestrial animals. I am imagining this happening in the warmer parts of the world, in the tropical seas where Man could stand being in the water for relatively long periods, that is, several hours at a stretch. I imagine him wading, at first perhaps still crouching, almost on all fours, groping about in the water, digging for shell fish, but becoming gradually more adept at swimming. Then, in time, I see him becoming more and more of an aquatic animal going farther out from the shore; I see him diving for shell fish, prising out worms, burrow-

* The amphibians went back only into freshwater (for certain physiological reasons), not into the sea.



Left, hair tracts of the dorsal and ventral surfaces of the trunk of a human foetus. Above, hair tracts of the human face; above right, of the scalp; lower right, of the human head. From Man's Place among the Mammals, by Frederic Wood Jones (Edward Arnold & Co. Ltd.).

ing crabs and bivalves from the sands at the bottom of shallow seas, and breaking open sea-urchins, and then, with increasing skill, capturing fish with his hands.

Let us now consider a number of points which such a conception might explain. First and foremost, perhaps, is the exceptional ability of Man to swim, to swim like a frog, and his great endurance at it. The fact that some men can swim the English Channel (albeit with training), indeed that they race across it, indicates to my mind that there must have been a long period of natural selection improving Man's qualities for such feats. Many animals can swim at the surface, but few terrestrial mammals can rival Man in swimming below the surface and gracefully turning this way and that in search of what he may be looking for. The extent to which sponge and pearl divers can hold their breath under water is perhaps another outcome of such past adaptation.

It may be objected that children have to be taught to swim; but the same is true of young otters, and I should regard them as more aquatic than Man has been. Further, I have been told that babies put into water before they have learnt to walk will, in fact, go through the motions of swimming at once, but not after they have walked.

Does the idea perhaps explain the satisfaction that so many people feel in going to the seaside, in bathing, and in indulging in various forms of aquatic sport? Does not the vogue of

the aqua-lung indicate a latent urge in Man to swim below the surface?

Whilst not invariably so, the loss of hair is a characteristic of a number of aquatic mammals; for example, the whales, the Sirenia (that is, the dugongs and manatees) and the hippopotamus. Aquatic mammals which come out of the water in cold and temperate climates have retained their fur for warmth on land, as have the seals, otters, beavers, etc. Man has lost his hair all except on the head, that part of him sticking out of the water as he swims; such hair is possibly retained as a guard against the rays of the tropical sun, and its loss from the face of the female is, of course, the result of sexual selection. Actually the apparent hairlessness of Man is not always due to an absence of hair; in the white races it is more apparent than real in that the hairs are there but are small and exceedingly reduced in thickness; in some of the black races, however, the hairs have actually gone, but in either case the effect is the same: that of reducing the resistance of the body in swimming. Hair, under water, naturally

loses its original function of keeping the body warm by acting as a poor heat conductor; that quality, of course, depends upon the air held stationary in the spaces between the hairs—the principle adopted in Aertex underwear. Actually the loss or reduction of hair in Man is an adaptation by the retention into adult life of an early embryonic condition; the unborn chimpanzee has hair on its head like Man, but little on its body.

Whilst discussing hair it is interesting to point out that what are called the "hair tracts"—the directions in which the hairs lie on different parts of the body—are different in Man from those in the apes; particularly to be noted are the hairs on the back, which are all pointing in lines to meet diagonally towards the mid-line, exactly as the streams of water would pass round the body and meet, when it is swimming forward like a frog. Such an arrangement of hair, offering less resistance, may have been a first step in aquatic adaptation before its loss.

The graceful shape of Man—or woman!—is most striking when compared with the clumsy form of the ape. All the curves of the human body have the beauty of a well-designed boat. Man is indeed streamlined.

These sweeping curves of the body are helped by the development of fat below the skin and, indeed, the presence of this subcutaneous fat is again a characteristic that distinguishes Man from the other primates. It was a note of this fact in the late Professor Wood Jones's book



In water, only the head needs protection from the rays of the tropical sun.

WAS MAN MORE AQUATIC IN THE PAST? *continued*



The seals are well on their way to an almost completely aquatic future—

Man's Place among the Mammals (p. 309) that set me thinking of the possibility of Man having a more aquatic past when I read it more than thirty years ago. I quote the paragraph as follows.

"The peculiar relation of the skin to the underlying superficial fascia is a very real distinction, familiar enough to everyone who has repeatedly skinned both human subjects and any other members of the Primates. The bed of subcutaneous fat adherent to the skin, so conspicuous in Man, is possibly related to his apparent hair reduction; though it is difficult to see why, if no other factor is invoked, there should be such a basal difference between Man and the Chimpanzee."

I read this in 1929 when I had recently returned from an Antarctic expedition where the layers of blubber of whales, seals and penguins were such a feature of these examples of aquatic life; such layers of fat are found in other water animals as well; and at once I thought perhaps Man had been aquatic too. In warm-blooded water animals such layers of fat act as insulating layers to prevent heat loss; in fact, in function they replace the hair. Man, having lost his hair, must, before he acquired the use of clothing, have been subjected to great contrasts of temperature out of water; in this connection it is interesting to note the experiments carried out at Oxford by Dr. J. S. Weiner, who showed what an exceptional range of temperature change in

air Man can stand, compared with other mammals. Man's great number of sweat glands enable him to stand a tropical climate and still retain a large layer of fat necessary for aquatic life.

This idea of an aquatic past might also help to solve another puzzle which Professor Wood Jones stressed so forcibly, that of understanding how Man obtained his erect posture, and also kept his hands in the primitive, unspecialized, vertebrate condition; for long periods, the hands could not have been used in support of the body as they are in the modern apes, which have never mastered the complete upright position. The chimpanzee slouches forward with his body partly supported by his long arms and with his hands bent up, to take the weight on the knuckles. Man must have left the trees much earlier; in all the modern apes the length of the arm is much longer than that of the leg. In Man it is the reverse. The puzzle is: how in fact did Man come to have the perfect erect posture that he has—enabling him to run with such ease and balance? Some have supposed that he could actually have achieved it by such running, or perhaps by leaping, but this does not seem likely. Let me again quote from Wood Jones, this time from his book *The Hallmarks of Mankind*, 1948, p. 78:

"Almost equal certainty may be attached to the rejection of the possibility that he ever served an apprenticeship as a specialized leaper or a

specialized runner in open spaces. But it is by no means so easy to reject the supposition that he commenced his career of bipedal orthograde progression as what might be termed a toddler, somewhat after the fashion followed in some degree by the bears."

It seems indeed possible that his mastery of the erect posture arose by such toddling, but performed in the water, like children at the seaside. Wading about, at first paddling and toddling along the shores in the shallows, hunting for shellfish, Man gradually went farther and farther into deeper water, swimming for a time, but having at intervals to rest—resting with his feet on the bottom and his head out of the surface: in fact, standing erect with the water supporting his weight. He would have to raise his head out of the water to feed; with his hands full of spoil he could do so better standing than floating. It seems to me likely that Man learnt to stand erect first in the water and then, as his balance improved, he found he became better equipped for standing up on the shore when he came out, and indeed also for running. He would naturally have to return to the beach to sleep and to get water to drink; actually I imagine him to have spent at least half his time on the land.

Tied up with his method of assuming the erect position is the problem of the human hand. Let me quote again from Wood Jones (*ibid.*, p. 80):

"In the first place, it seems to be



while Man's enjoyment of the sea may be a link with an aquatic past.

perfectly clear that the human orthograde habit must have been established so early in the mammalian story that a hand of primitive vertebrate simplicity was preserved, with all its initial potentialities, by reason of its being emancipated from any office of mere bodily support. Perhaps the extreme structural primitiveness of the human hand is a thing that can only be appreciated fully by the comparative anatomist, but some reflection on the subject will convince anyone that its very perfections, which at first sight might appear to be specializations, are all the outcome of its being a hand unaltered for any of the diverse uses to which the manus of most of the 'lower' mammals is put. Man's primitive hand must have been set free to perform the functions that it now subserves at a period very early indeed in the mammalian story."

Man's hand has all the characters of a sensitive, exploring device, continually feeling with its tentacle-like fingers over the sea-bed: using them to clutch hold of crabs and other crustaceans, to prise out bivalves from the sand and to break them open, to turn over stones to find the worms and other creatures sheltering underneath. There are fish which have finger-like processes on their fins, such as the gurnards; they are just such sensitive feeling organs, hunting for food, and they, too, have been known to turn over stones with them while looking for it.

It seems likely that Man learnt his tool-making on the shore. One of the few non-human mammals to use a tool is the Californian sea-otter, which dives to the bottom, brings up a large sea-urchin in one hand and a stone in the other, and then, whilst it floats on its back at the surface, breaks the sea-urchin against its chest with the stone, and swallows the rich contents. Man no doubt first saw the possibilities of using stones, lying ready at hand on the beach, to crack open the enshelled "packages" of food which were otherwise tantalizingly out of his reach: so in far-off days he smashed the shells of the sea-urchins and crushed lobsters' claws to get out the delicacies that we so much enjoy today. From the use of such natural stones it was but a step to split flints into more efficient tools and then into instruments for the chase. Having done this, and learnt how to strike together flints to make fires, perhaps with dried seaweed, on the sea-shore, Man, now erect and a fast runner, was equipped for the conquest of the continents, the vast open spaces with their herds of grazing game. Whilst he became a great hunter, we know from the middens of mesolithic Man that shell fish for long remained a favourite food.

In such a brief treatment I cannot deal with all the aspects of the subject: I shall later do so at greater length and in more detail in a full-scale study of the problem. I will just here mention

one more point. The students of the fossil record have for so long been perturbed by the apparent sudden appearance of Man. Where are the fossil remains that linked the Hominidae with their more ape-like ancestors? The recent finds in South Africa of *Australopithecus* seem to carry us a good step nearer to our common origin with the ape stock, but before then there is a gap. Is it possible that the gap is due to the period when Man struggled and died in the sea? Perhaps his remains became the food of powerful sea creatures which crushed his bones out of recognition, or could his bones have been dissolved, eroded away in the tropical seas? Perhaps, in time, some expedition to investigate tropical Pliocene (coastal) deposits may yet reveal these missing links.

It is interesting to note that the Miocene fossil *Proconsul*, which may perhaps represent approximately the kind of ape giving rise to the human stock, has an arm and hand of a very unspecialized form: much more human than that of the modern ape. It is in the gap of some ten million years, or more, between *Proconsul* and *Australopithecus* that I suppose Man to have been cradled in the sea.

My thesis is, of course, only a speculation—an hypothesis to be discussed and tested against further lines of evidence. Such ideas are useful only if they stimulate fresh inquiries which may bring us nearer the truth.



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by JOHN WEST

Technical Adviser, P & O

PASSENGER liners are by far the largest units employed in transporting people, and once they are built, their life is upwards of twenty years. It is, therefore, very important that each individual ship should as far as is possible incorporate the latest features of passenger liner design. It is not unreasonable to say that the new P & O liner *Canberra* goes one better than this, as her design includes the results of much original research and development work.

With a gross tonnage of 45,000 tons, the *Canberra* is half as large again as any previous ship in the P & O fleet, and her service speed of 27½ knots is similarly about five knots higher. This advance in size and speed was dictated by commercial reasons, and was necessary to meet the challenge of today's shipbuilding prices and passenger-carrying economics. But it also meant that the ship had to be designed more or less *ab initio*, and this gave an excellent opportunity for a fresh approach to design problems.

One of the early decisions made was to put the engines in the after end of the ship. The *Canberra* is not new in

this respect, but the number of passenger liners with this layout is still quite small, and she is by far the largest ship of this type to have it. The advantages are that the passengers can occupy the whole of the centre portion of the ship, where the motion is least. There is more space for passenger accommodation. Weight is reduced, mainly because the propeller shafts are shorter. Noise is reduced, as machinery and passengers are well separated.

Another early decision was that steam turbines with electric transmission would be used to drive the ship. This type of machinery is not generally popular, as it is somewhat heavier and more expensive than geared turbines. However, the P & O Line has had very satisfactory experience with turbo-electric machinery in some of its older ships; the flexibility of layout assists in arranging the machinery in the stern of the ship; and the electric drive gives a reduction in noise and vibration. This last point, the reduction of noise in the ship, has been given a great deal of attention throughout the design, and more will be said about it later.

The shape of the hull was decided after a long series of tests in ship model tanks. Much of this work was done by the National Physical Laboratory at Teddington, but a notable contribution was made by the staff of the model tank of a Clydeside shipyard, William Denny & Brothers. There were little basic data available for ships of this size having a speed/length ratio ($V/\sqrt{L}$) of unity, so it was necessary to build up these data by performing a whole range of experiments. Since we were determined to produce the most efficient ship possible, many other investigations were carried out. Ideas which were investigated included a stern with twin skegs—the fin-like narrowing of the stern before the rudder; the use of a bulbous bow; and the use of open propeller shaft brackets in place of the normal bossings.

It was found that the twin-skeg stern was not an improvement, but the other two ideas were adopted. The forefoot of the ship below the waterline expands into a prominent bulb (see first photograph on next page). This bulb gives buoyancy to the bows of the ship well below the waterline and allows the lines

at water level to be very fine. This very fine entry reduces the bow wave and hence the wave-making resistance of the ship.

Open propeller shaft brackets are normal practice in warships, but are little used in merchant ships. In the *Canberra* the final 75 feet of the two propeller shafts is outside the hull, supported only by a bracket immediately before the propeller and another halfway along the length of exposed shaft, whereas the normal practice in a merchant ship is to enclose the shafts in the hull by drawing out the hull at this point into a suitably streamlined shape. The open brackets give a better flow of water to the propellers and improve their efficiency (see second photograph below).

The propellers themselves have been subjected to a similar series of model tests, both in cavitation tunnels and in conjunction with the ship model in self-propelled model tests. The resulting

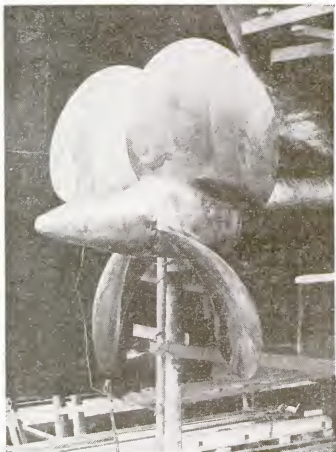
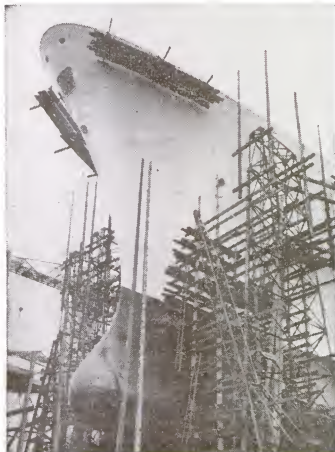
four-bladed propellers are not of unusual appearance in any way, but we are confident that they will prove efficient in transmitting 85,000 shaft horsepower between them without causing vibration.

Experimental work in recent years has shown the tremendous importance of a smooth surface in reducing the resistance of ships' hulls, even though laminar flow cannot be achieved. The hull plating of the *Canberra* is very largely welded, giving flush joins, and though the frames are riveted to the plating the heads of the rivets are well countersunk. This is now common practice in ships, but the *Canberra* is one of the first being painted externally with epoxy resin-based paints. These paints have so far been used in ships mainly inside the cargo tanks of oil tankers. They require special preparation of the steel surface before application, but they give a remarkably hard,

smooth and corrosion-resistant surface with a longer life than normal oil-based paints.

A further series of experiments was concerned with the above-water shape of the ship. These were wind tunnel experiments, the purpose of which was to ensure that conditions on the decks of the *Canberra* are suitable for passengers. If the ship is travelling at 27½ knots into a 20-mph wind, the air speed over the decks will be about 50 mph, and this has to be reduced to about 5 mph in spaces which passengers will use. The reduction has been achieved mainly by the use of permanent glazed screens down the sides of the open decks, with additional transverse screens that can be opened or closed as conditions demand.

The streamlined shape of the bridge has also been designed to help as far as possible in keeping wind off the decks behind it. Here, unfortunately, art and



Left, the bulbous bow of the *Canberra* which gives buoyancy and allows the shape at the waterline to be made finer. Right, one of the two four-bladed propellers with its bracket-supported open shaft which improves the water flow.

RESEARCH FOR THE CANBERRA *continued*

science are at loggerheads. A streamlined bridge structure is demanded by modern taste; but such a shape costs more to build, causes no significant reduction in the resistance to motion of the ship and can complicate the problem of wind on the decks behind. Whereas the old rectangular type of bridge structure broke up the air flow completely, a streamlined one may tend to induce a vacuum in its lee, and this is filled by a strong current of air coming around one side or other.

One field in which serious research has not previously been undertaken for ships is the acoustical insulation of passenger accommodation. A fairly high background noise level is normal in ships, arising both from the main propelling machinery and also from local sources such as ventilating systems. The ear fairly quickly accustoms itself to this noise, and, indeed, if for any reason the machinery is all shut down, the ship seems (and is) dead.

This steady background noise had the advantage that it tended to drown out and probably more irritating noises from adjacent cabins or other passenger spaces. But with air-conditioned ships (in which portholes must be kept closed) and with the modern trend towards reducing noise and vibration, it is found that local noises become more prominent. Before the bulkheads for the *Canberra* were designed, a considerable amount of research work was undertaken on behalf of the P & O Company by Acoustical Investigation and Research Organization Ltd. To begin with, engineers with calibrated tape-recording

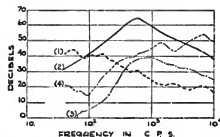


FIGURE 1. Noise spectra in cabins. Curve 1 represents the mean noise level in the twelve quietest cabins encountered during a survey; curve 2 is the spectrum of loud speech in cabins; curve 3 is the difference between curves 1 and 2 and represents the sound transmission loss required from the insulation; curve 4 is the actual transmission loss in the partition designed for the *Canberra*—it is greater than that given by curve 3 at all frequencies.

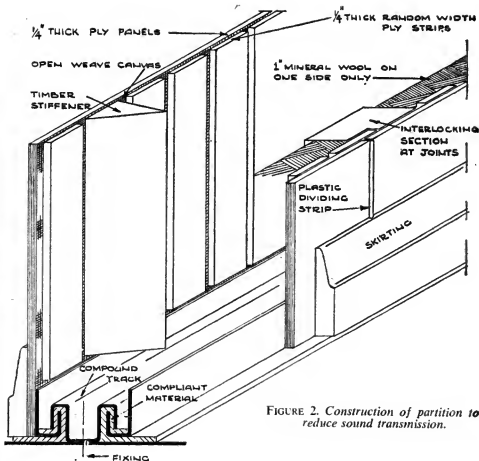


FIGURE 2. Construction of partition to reduce sound transmission.

equipment were sent on board a number of passenger liners, where they made recordings in a large number of cabins and other spaces, as well as obtaining from passengers their opinions as to the most annoying noises.

These investigations showed clearly that the most irritating source of noise was the human voice, with plumbing noises second. To defeat these, the traditional methods are to employ partitions incorporating either considerable mass, or large cavities, or a combination of both. In this case it was essential, of course, that both the weight and the thickness of bulkheads should be kept to a minimum. Recent experiments in America have shown that the cutting of slots in a plywood panel has the effect of lowering the resonant frequency and raising the critical frequency of coincidence, while at the same time giving a useful improvement in the transmission loss between these two frequencies. It was decided to apply this principle to a double isolated skin partition.

In Figure 1, curve (1) shows the minimum ambient noise level likely to be achieved in practice. It was obtained by the analysis of tape recordings at one-third octave intervals from 40 to

10,000 cycles per second, taking the arithmetic mean of about twelve of the quietest cabins encountered during the trials. Similar analysis of loud speech in cabins produced curve (2), and the difference between these two sound levels thus represents the transmission loss required for the bulkhead. This difference, with a safety margin of three to four decibels added, is shown as curve (3).

The construction adopted for the partition is shown in Figure 2. Strips of plywood of random width were fixed by adhesive to open-weave canvas, and this in turn was applied to the back of the face panels. The panels for one side of the partition had a layer of absorbent wool added, and both sides were then secured to a special compound metal and rubber section. Tests on the resulting bulkhead gave a transmission loss which appears as curve (4) in Figure 1, and it will be seen that this loss is higher at all frequencies than that required.

We hope that the work which has been put into the design of the *Canberra* will ensure that she is a successful ship when she enters service next year. We think that it will and that passengers will appreciate its benefits.

Possible uses of microwaves for telecommunication

World-wide links and broadcasting from space satellites are likely applications of very short electromagnetic waves. Propagation in hollow metallic conductors may provide enough television, telephony and telegraphy circuits to meet the largest foreseeable demands

by *W. J. BRAY*
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MICROWAVES are electromagnetic waves similar in character to the radio waves used, for example, in television and frequency-modulation sound broadcasting, but are of very much shorter wavelength; for present purposes the range of wavelengths of interest is from about 30 cm. to 3 mm., the corresponding frequency range being from about 1,000 Mc/s to 100,000 Mc/s (1 to 100 Gc/s).

Microwaves have a remarkably wide range of applications in telecommunications. The existing applications range from single links tens of miles long providing a few telephone circuits, to transcontinental networks providing several television channels and many hundreds of telephone circuits over distances of thousands of miles. These latter systems use repeater stations spaced thirty miles or so apart, with line-of-sight paths between adjacent stations. In addition, recent developments in tropospheric-scatter systems have shown that a "line-of-sight" path is not essential and that, if

very large aerials and high-power transmitters are used, a hundred or so telephone circuits or a television channel of moderate quality can be provided well beyond the horizon to distances of two hundred miles or more.

Future applications of microwaves may well include space communication systems providing not only communications from Earth to space vehicles, but also direct intercontinental links between points on Earth thousands of miles apart. Another, though more distant, possibility is that world-wide broadcasting from space satellites will be achieved.

The future may also see the use of long-distance waveguide systems employing microwaves with wavelengths between 3 and 10 mm., that is, frequencies between 100 and 30 Gc/s. Such systems would have a very large capacity for transmitting information and would be well suited to the provision of the many thousands of telephone circuits and several tens of television-type channels which may be required in the future

between the main centres of population in highly industrialized countries. The television-type channels would provide not only links for television broadcasting but links for closed-circuit television, subscriber-to-subscriber television, and for high-speed data and facsimile transmission.

Line-of-sight Microwave Systems.—Microwaves are propagated most effectively, that is with the least attenuation, over line-of-sight paths. This has led to the widespread use of microwave systems with repeater stations spaced some thirty miles apart, shorter or greater distances being used where the terrain requires or permits it (Figure 1).

The frequencies used for such systems are mainly in the range 2,000 to 8,000 Mc/s, although frequencies as high as 12,000 Mc/s are coming into use for shorter links. Above about 12,000 Mc/s the additional attenuation due to rain, hail, sleet and the oxygen and water vapour present in the atmosphere is excessive.

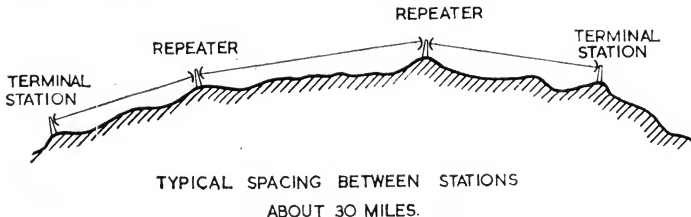


FIGURE 1. *Line-of-sight microwave system.*

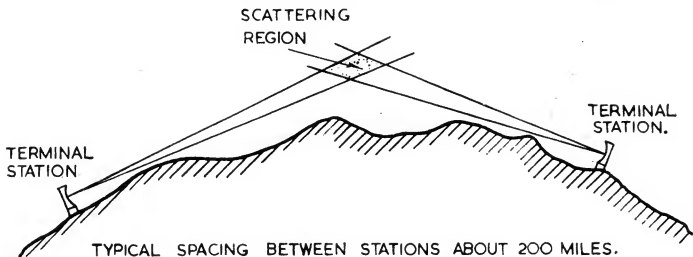
POSSIBLE USES OF MICROWAVES FOR TELECOMMUNICATION *continued*

FIGURE 2. Tropospheric-scatter system.

Microwave equipment of current design can accommodate up to about 1,000 telephone circuits or a television channel of 6 Mc/s video bandwidth (suitable for up to 625-line television signals) on each radio carrier; a number of radio carriers can be provided on a given route sharing the same aerials and feeders. The frequency bands currently used for main trunk microwave links are centred on 2,000, 4,000 and 6,000 Mc/s; these bands are 400 to 500 Mc/s wide and each accommodates six or eight "go" and six or eight "return" radio carriers. Thus large capacity systems can be built up, equivalent, for example, to twenty television channels or twenty thousand telephony circuits on a given route.

The transmission performance of well-designed microwave systems is comparable with that of coaxial cable systems and, since the cost of microwave systems often compares favourably with that of cable systems, there has been a widespread use of microwave systems in many countries. In the United States, for example, more than 80 per cent. of the long-distance television facilities and 30 per cent. of the trunk telephone facilities are now provided by microwave systems. The British Post Office is using microwave links extensively for relaying television, and the Eurovision network largely consists of microwave links.

The future development of line-of-sight microwave systems will be towards systems providing still larger capacity on each radio carrier, perhaps 2,000 telephony circuits, or a television channel and up to 600 telephony circuits.

Tropospheric-scatter Systems. — In some cases the line-of-sight requirement of conventional microwave systems is an irksome restriction or even a com-

plete barrier where long stretches of water, mountain ranges or difficult terrain have to be crossed. In these circumstances tropospheric-scatter systems may be used to provide satisfactory, if not absolutely first-grade, circuits for telephony and television.

This technique uses the weak signals scattered from irregularities in the distribution of the refractive index of the atmosphere up to heights of several miles (Figure 2). Because the scattered signals are much weaker than those incident on the scattering region, very high-power transmitters, up to 10 kW or more, and large high-gain aerials, up to 60 feet in

diameter, are usual on the longer paths.

The frequency range useful for tropospheric-scatter systems is from about 500 to 5,000 Mc/s, the lower frequencies being more effective for the longer paths.

At the present time it is practicable to provide up to about 200 telephone circuits or a television channel over distances of about 200 miles, using 10 kW transmitters and 60-foot aerials; smaller numbers of telephone circuits can be provided over still greater distances. The ranges that can be achieved in practice are likely to be extended significantly by the application of low-noise amplifier techniques (parametric amplifiers, low-

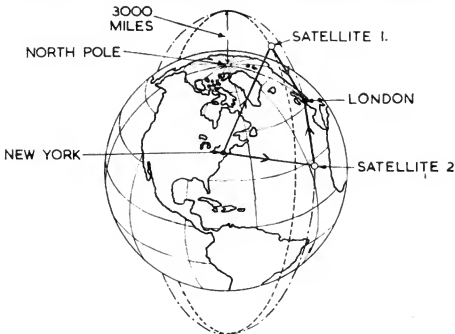


FIGURE 3. Polar (3,000 miles) orbit satellite system.

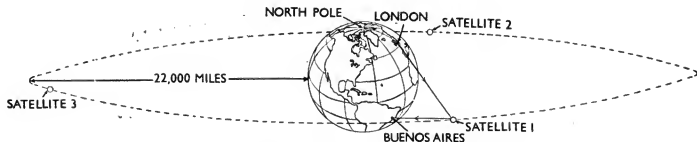


FIGURE 4. Equatorial (22,000) miles orbit satellite system.

noise travelling-wave tubes, Esaki diodes, etc.) now under development. Alternatively, these devices may be used to reduce the transmitter power or size of aerial needed, thus reducing the cost.

Tropospheric-scatter systems have certain disadvantages which arise from the use of high-power transmitters and the scatter mode of propagation, and as a result interference to other systems sharing the same frequency band may occur over distances of hundreds of miles. Although such interference can be mitigated by careful frequency planning, this entails the use of additional frequency space, and tropospheric-scatter systems thus tend to be appreciably less economical than line-of-sight systems in their utilization of the spectrum. Furthermore, because of the multi-path characteristics of tropospheric-scatter propagation, such systems have a smaller effective bandwidth and consequently less transmitter capacity on each radio carrier, as compared with line-of-sight systems.

Thus tropospheric-scatter systems are unlikely to supplant line-of-sight microwave or coaxial cable systems where the terrain is suitable for the latter; on the other hand, tropospheric-scatter systems have a valuable if limited field of application in difficult terrain or to over-water paths up to two or three hundred miles in length. Tropospheric-scatter systems have been used, for example, on over-water paths between Florida and Cuba, Florida and Bahamas and there are extensive networks of such systems in use in Alaska and Canada.

Space Communication Systems.—The successful launching of artificial satellites into orbit around the Earth has opened up a new vista in the use of microwaves for long-distance communications. By using the satellites as passive or active repeaters it may well prove possible to provide blocks of hundreds of telephone circuits, or several television channels, between points on the Earth's surface thousands of miles apart.

The proposals so far made for space communication systems fall into two main classes:

- (1) those using passive or active repeaters in 1,000- to 3,000-mile orbits, with two- to three-hour periods of rotation around the Earth (Figure 3);
- (2) those using passive or active repeaters in a 22,000-mile equatorial orbit, stationary with respect to the Earth (Figure 4).

A passive repeater is one which relies on the reflection or scattering of microwaves from a metallic surface, possibly in the form of metallized fabric balloons 100 feet or more in diameter, much as light is reflected from a polished surface. Such a repeater could be used simultaneously by many communication systems, provided that different frequencies were employed. The technique also has the advantage of great simplicity so far as the satellite repeater is concerned, but would require very high transmitter powers, large steerable aerials, possibly 100 feet or more in diameter, and very sensitive receivers at the ground stations. There is an additional hazard in that the metallized fabric balloons are susceptible to puncturing by micrometeorites and may have short lives; however, alternative longer-life passive structures can be envisaged.

An active repeater is one equipped with a receiver, a low-power transmitter and the necessary receiving and transmitting aerials. Power for the active equipment would be derived from solar batteries energized from the Sun's rays; means for storage of electrical energy would be necessary to maintain continuous operation whilst the satellite is in the Earth's shadow. Such an arrangement would, of course, be much more complex than the passive repeater, but it would have the advantage of greatly reducing the transmitter power and size of aerial needed at the ground stations.

In the case of satellites using the 1,000- to 3,000-mile orbits, a given

satellite would be visible simultaneously from two points on the Earth's surface, say London and New York (Figure 3), for only a fraction of each orbit. Thus to provide substantially continuous communication it would be necessary to put into orbit a number of satellites, some thirty or more being required for 99.9 per cent. continuity. Furthermore, the narrow beams of the transmitting and receiving aerials would have to track each rapidly moving satellite with great precision.

The 22,000-mile equatorial orbit satellite system (Figure 4) is of particular interest, since at this radius each satellite would be stationary relative to points on the Earth's surface, and only three satellites would be needed to provide substantially world-wide coverage. In addition, the aerials at the ground stations and in the satellites could be fixed in direction. Unfortunately, the large distances involved almost rule out passive systems, and active repeaters would almost certainly be required. There is additional disadvantage in that the transmission time to and from the satellite, about 0.25 second, is large enough to be troublesome for two-way public telephony. However, this disadvantage would not be significant for essentially one-way circuits—for example, for telegraphy, music circuits and television links.

The frequency range most useful for satellite communication systems would appear to be from about 1,000 to 10,000 Mc/s. Below 1,000 Mc/s cosmic noise—that is, noise from the star galaxy—sets a limit to the usable receiver sensitivity. At the higher frequencies, noise from the Earth's atmosphere and increased losses due to rain, hail, and sleet are limiting factors, particularly when long paths through the atmosphere are involved.

Twenty-two-thousand-mile orbit satellite systems have also been suggested as a possible means for establishing a world-wide sound and television broadcasting system, the signals broadcast

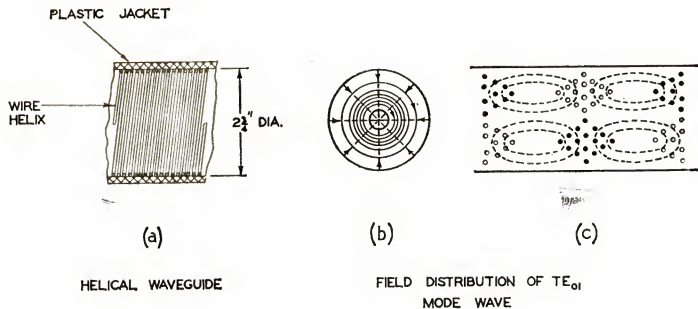
POSSIBLE USES OF MICROWAVES FOR TELECOMMUNICATION *continued*

FIGURE 5. Long-distance waveguide system.

from the satellite being received directly in the listeners' and viewers' homes. A satellite television broadcasting system would need to use frequencies well above those currently used for television broadcasting—in fact, in the microwave range above 1,000 Mc/s. The transmitter power required would be of the order of 100 kW; although this would present major engineering problems, they may not in the long run be insuperable.

At the present time it appears that the 1,000- to 3,000-mile orbit passive reflector system referred to above may be the most practicable and useful technique for civil point-to-point communications. In this connection it is of interest that the National Aeronautics and Space Administration of the United States has recently announced its intention of putting a number of 100-foot diameter metallized fabric balloons into orbit early in 1960. If this is accomplished, propagation tests will be made, in co-operation with the Bell Telephone Laboratories, between California and New Jersey. It must be stressed, however, that many major problems outside the radio field would need to be solved before space communication systems could become practicable.

Long-distance Waveguide Systems.—All

the microwave systems so far discussed have employed radio waves propagated in substantially free space. By contrast, the long-distance waveguide systems now under development use microwaves propagated in hollow metallic conductors. The microwaves of interest in this application are in the wavelength range 0.3 to 1 cm.—that is, the frequency range 100 to 30 Gc/s. These microwaves are subject to considerable losses in the atmosphere due to rain, hail and sleet. Even in fine weather the oxygen and water vapour in the atmosphere give rise to losses which would make normal radio links impracticable except over very short distances.

Fortunately, these short microwaves can be propagated with relatively low attenuation in cylindrical waveguides provided they are introduced in a particular manner, known technically as the TE₀₁ mode. This means that the electric vibration in the wave should operate in circles at right angles to the direction of travel (Figure 5 b and c). In theory, in an ideal waveguide, the attenuation decreases as the frequency is increased; in practice, the attenuation rises above a certain frequency, but there is a broad band between about 30 and 100 Gc/s where the attenuation in a 2 1/2-inch dia-

meter waveguide is small enough to enable the repeaters to be spaced ten to twenty miles apart.

One form of long-distance waveguide that is now being investigated consists of a continuous wire helix, 2 1/2 inches in diameter, with a supporting plastic jacket, as shown in Figure 5 (a). This form of construction has enabled a considerable advance to be made in the suppression of unwanted modes of propagation which would otherwise seriously impair the transmission characteristics.

Although many major problems remain for solution, it was evident from the papers presented at the Long-distance Waveguide Convention held by the Institution of Electrical Engineers in February, 1959, that some progress has been made towards the goal of a practicable and economic long-distance waveguide system. When this goal has been achieved, a single waveguide may be expected to provide enough telephony, telegraphy and television circuits to meet the largest demands for the foreseeable future.

(The permission of the Engineer-in-Chief, General Post Office, to publish this article is gratefully acknowledged.)

SCIENCE IN INDUSTRY

Plastic covers formed in vacuum

PVC sheeting specially compounded for use in vacuum covering is intended to make the technique more attractive economically and to give a more satisfactory product. Besides polyvinyl chloride, the new formulation contains a polymeric plasticizer, instead of the more usual monomeric variety, and suitable stabilizers. The polymeric plasticizer was chosen because it exhibits little tendency to migrate into the adhesive joining the sheet to the article being covered: such migration is likely to weaken the bond and cause delamination. That Plastovac-P, as the material is called, appears to show less evidence of ageing than ordinary PVC is also thought to be due to the polymeric plasticizer which scarcely evaporates on prolonged exposure.

Although thermoplastic, the sheeting is reported to retain embossed patterns at the relatively high temperatures associated with vacuum covering. Because of its low elastic recovery, creep or contraction are negligible and the sheeting faithfully follows the contours of the article. Before application the sheeting is softened by exposure to radiant heat: then the vacuum draws it over the article which acts as a mould. The operation, carried out on existing vacuum forming machinery, is completed in several seconds and so easily competes with conventional methods of covering by hand which can take about twenty minutes. Plastovac is a product of Storeys, of Lancaster, who hope to interest diverse manufacturers in this inexpensive, decorative and hard-wearing finish for items like radio cabinets, furniture and luggage.

Infra-red food blanching

INFRA-RED blanching is to be preferred to steam or boiling water treatment as a means of preparing apples, celery, peas, and potatoes for canning and freezing. This has been proved by Canadian scientists working under the leadership of Dr. E. A. Asselbergs at the Federal Plant Research Institute—pioneers in the application of infra-red blanching to fruit and vegetables. Not only did they find that this form of dry heat treatment prevents the loss of flavour and nutrients which tend to be leached out when steam or water is used, but it also improves the texture and appearance of the products. Potatoes, french fried after infra-red irradiation, absorb less fat. The infra-red system has the added advantage that, since less process water is needed, useful economies can be achieved in handling and storage. The radiation sources being used experimentally include quartz tubes operating in the temperature range 1,400° to 1,800° F. and quartz lamps having a filament temperature of 4,000° F.

The technique has already been applied commercially to Canadian grown celery by an Ontario food company. Their 20-foot infra-red tunnel, which has an hourly output of 1,000 lb. of finished product, is used to prepare celery in September for manufacturing during the winter, taking the place of expensive imported celery. Apple peeling by infra-

red heat, on trial in the Federal laboratory, is proving far less wasteful than mechanical peeling. By the latter method, 15 to 18 per cent. of the apple's weight is lost, compared with only about 2½ per cent. when heat peeling is used.

Certain vegetables have proved difficult to process by infra-red treatment. These include asparagus, turnips and carrots. But as more basic information is accumulated the scope of the process may be widened. Oddly enough, the subject seems to have attracted little interest in Britain and other countries. The Canadians are the only scientific team known to be engaged in this potentially rewarding line of research.

Electronic eye on assembly



Transistors can be assembled at the rate of 1,800 in an hour by this automatic system engineered in the United States. The electromechanical machine consists of six turntables, two ovens for alloying and bonding and a welding unit. The components—including germanium disk, "whisker" wires and mounting base—are fed automatically into the turntables, each of which injects one component into the small carbon cylinders or "boats" that serve to position and transport the parts on the conveyor belts. Photo-cells and mechanical devices at each turntable operate to reject boats with missing or badly positioned components. The system was designed and engineered at the Poughkeepsie plant of IBM.

SCIENCE IN INDUSTRY *continued*

Making hay in a day

AMONG the latest of the many American machines to be introduced to the British farmer in recent months is the Colman bale elevator. It is being manufactured in this country under licence by Colman & Company (Agricultural) Ltd. as an essential part of their short-cut hay-making system. One of the other essentials is a tractor-drawn German-made Fella tedder, which fluffs up the swaths of cut grass left by the mower and, it is claimed, enables the farmer to make the hay in a day, instead of three or four by more conventional methods. The tugged hay is baled and can then be dried properly in the barn by the Templewood-Colman barn hay drying fan installation, a twin-fan and heater system blowing warm air through the middle of the bales. Such a system of drying needs to be used with care, otherwise the outside of the bales become brittle—with the consequent heavy loss of leaf—while the insides are left still moist and uncured.

The bale elevator is perhaps the most interesting machine of the three, if only for its lightness and simplicity. It is made of sections weighing only 6 lb. per foot length and



The Colman bale elevator.

the chain-driven elevator can handle any shape or size of bale. Working with a small petrol motor bolted to a bracket at the base, it sends the bales up at the rate of about a foot in two seconds, just fast enough for a man at the other end to tidy them up as they are pushed off the elevator. The main part of the elevator can have an angle up to 60° and a length of 42 ft., while the horizontal extension can stretch to 125 ft. in 8 ft. or 4 ft. sections. This extension can be suspended from the barn beam trusses and a bale

diverter can be adjusted to slide the bales off anywhere along the conveyor. An elevator for normal barn use would cost about £220.

A microscope with an elastic lens

FROM Japan comes a microscope embodying the zoom principle. The zoom lens is well known in cinematography, but the Nichinan Sangyo Company, of Tokyo, seems to have been the first successfully to reduce it to the dimensions of the microscope. The basic idea is to provide a lens system in which the focal length or image magnification can be continuously varied while a sharp image is automatically maintained by mechanical means. In the Nipolen microscope, as the new instrument is called, such a system of lens components is used to allow the magnification to be altered from $\times 300$ to $\times 900$ while the image remains in perfect focus.

With the help of this microscope the examination of largish samples—fibres, powdered chemicals, pigments or frits for enamelling, say—at high magnifications is obviously speeded up considerably. The operator can rapidly scan across the slide and, if something of interest comes into view, increase the magnification simply by turning the graduated zoom ring.

The microscope has been under development since 1953 and patents are pending in a number of countries. Northgate Traders (City) Ltd., of London, EC2, are the sole agents for Great Britain. The price is £85.

Cores made without ovens

A NOVEL technique for the making of cores for moulding purposes has been patented by the French firm of Renault. It is known to embody an entirely new type of binder which gives quick setting in the core box without the subsequent baking which is usually necessary. It also involves special methods of filling and ramming the heated core boxes and of withdrawing the core afterwards.

The older method of making cores was to mix the sand with a binder and mould it in a core box of wood or metal, then remove it from the box and put it into an oven where the oxidation processes over a fairly long period hardened it. It was then ready to be put into the mould. The French method is understood to show a notable advance on even the latest of the ordinary techniques.

Bubbles in the glass

FOAMED glass—similar in structure to foamed plastics and as easy to exploit—has been produced in Sweden as an insulating material. It can be worked with carpenter's tools and is best fixed in roofs, floors and walls by means of asphalt.

The glass is given its special character by having many closed glass cells filled with "a gas mixture." It is impervious to water, steam and gases. Bönnefycke & Thorö, the Malmö firm who are marketing the material, call it "Bisol Skumglas".

SCIENCE IN INDUSTRY *continued*

A jibless crane

A NEW kind of mobile crane, which substitutes a vertical mast with a T or hammer-shaped head for the familiar strut type jib and can be slewed through 360 degrees by swinging the whole platform on which it is mounted, has just gone into use at two ports in Scotland and Northern Ireland. The load is lifted by four cables running over pulleys from the masthead and is prevented from swinging by slightly tilting the mast so that the load rests against a pad on the mast.

This crane was evoked by the need to handle quickly and precisely big containers up to 20 ft. long and 12 tons in weight, in which raw materials and finished products are moved between Northern Ireland and other parts of the United Kingdom. Four ships are engaged in this traffic and some can carry thirty-eight containers at a time. Port facilities do the lifting into and out of the ships' holds, but quick clearance of quaysides was found to be necessary if full use was to be made of favourable tide conditions.

To meet the circumstances, a crane capable of moving such loads in narrow aisles was wanted. It was designed therefore with a short tail radius both to permit slewing in confined spaces among ranks of parked containers and also to enable the load to be put on or taken off the transport trailer. In slewing, the whole platform revolves on a double ring of steel ball bearings so that there is no need for a centre post.

The crane was made by Steels Engineering Products Ltd., Sunderland, to the requirements of Anglo-Continental Container Services Ltd., and is working at Ardrossan and Larne.



The new crane, having hoisted a typical container out of the middle of a rank of containers, is slewing before placing its load on the semi-trailer for removal.

Reflections of crystal structure

A DIFFRACTOMETER which can determine the orientation of crystals in any plane without resetting is on offer now to those industries which need to check or seek to improve the grain or crystalline structure of their products—high grade metals, for example. It has emerged during the past two years from the needs of the Atomic Energy Authority.

An instrument for the examination of uranium bars in quantity was wanted. The crystals of uranium when subject to heat are likely to grow along two axes at different rates and to shrink in the third axis, with consequent buckling and twisting—a most undesirable condition when the bars are contained in fuel cans. To prevent it, the widest possible differentiation in the orientation of the crystals is desirable.

By obtaining an instrument capable of defining the orientation quickly in all planes, the Harwell metallurgists have saved a good deal of time. The new diffractometer, an X-ray instrument, makes use of a technique of determining the preferred orientation of crystals known as the Shulz method whereby the intensities of reflections can be related, without correction, to the number of crystals reflecting. Only the simple adjustment of the goniometer ring is required to examine the crystal structure of a specimen in any plane.

Seaton Creaghe Engineering Ltd., London, NW10, designed and manufactured the instrument which is now on

the market at £1,750, delivery within four months. It is expected to find applications in the chemical, mineral, mining, metal and semi-conductor industries.

Heat turned on snowdrifts

SNOW has been swept away, blown away and sucked away. Now it is to be thawed away by a vehicle which uses heat for the purpose and, by following up the heat with a rotary brush and a squeegee at the rear, leaves the road or runway in a state of "dry dampness". The method of delivering the heat is not unlike that by which sections of road are baked in readiness to receive the familiar asphalt surface.

The heat is developed by a series of swirl-type oil burners disposed in a battery along a working head which is adjustable in tilt forward and downward in fairly close proximity to the snow-laden surface. The oil is pumped to the burners, combustion air comes from a compressor, both being worked from the vehicle's power unit. This is reported capable of clearing a 6-in. layer of snow on a 9-ft. front at the rate of 4 mph and also to be able to tackle drifts up to 7 ft. deep.

A two-man team can manage this cooker, and the operating cost, including labour, is given as 35s. an hour for the town model and 45s. an hour for the bigger country model. The limit of the town type is a 3-ft. drift. This device has been named the Snow Locust. It is made by Mobile Jet Dispersals Ltd., Newcastle on Tyne.



A Technical Cadet checks the focal length of a microwave metal-plate lens designed and constructed by students at the R.A.F. Technical College, Henlow.

Man of Science - Man of Action

An R.A.F. Technical Officer gets the best of both worlds. A permanent commission in the Technical Branch of the Royal Air Force is a scientific career which can also satisfy a man with a love of adventure. Few careers offer the scientist a more thorough training than the R.A.F. Technical College, Henlow. The cadet learns not only his own technical specialisation but also the art of leadership.

There are two main types of training. Two-thirds of the cadets take a course at Henlow leading to H.N.D. in mechanical or electrical engineering. One-third spend a year at Henlow and then read for the Mechanical Sciences Tripos at Cambridge or a comparable course at another university. They then return to Henlow for a further two terms. All cadetships lead to permanent commissions in the R.A.F. Every cadet has the chance of learning to fly if he is fit and willing.

Financially, an R.A.F. Technical Officer compares favourably with his civilian counterpart, and promotion to high rank is open to him. His work may take him to Washington or to Woomers. In the opportunities it offers for advanced study and contact with a wide range of new developments, his career is unique.

Qualifications for Entry. Candidates for technical cadetships must be between 17 and 19½ and hold (or expect to obtain by Summer 1960) passes in G.C.E. (or equivalent) at 'A' level in physics and pure and applied mathematics, plus 'O' level passes in English language, chemistry and two other subjects.

R.A.F. Scholarships. Tax-free scholarships, paid irrespective of family income, are available for boys in the U.K. over 15 years 8 months to help them stay at school until qualified to enter Henlow.

For details of Technical Cadetships, R.A.F. Scholarships, new pay increases and improved pensions, write before 14th May 1960 to Group Captain J. N. Ogilvie, A.F.C., A.F.M., Air Ministry (NB 65), Adastral House, London, WCI.

The
Royal Air Force
Technical College
Henlow

SCIENCE IN INDUSTRY *continued*

Tungsten fabricated by plating

FOR making entire articles from tungsten or merely giving them a coat of the metal, the United States Bureau of Standards has devised a vapour deposition technique. It differs in detail from a number of processes similar in intention that have lately been announced. All of them were no doubt inspired by the desire to exploit the structural strength of tungsten at high temperatures. Rockets, missiles and jet engines provide obvious openings for a metal which retains its strength above 2,000° C., has a high melting point (3,140° C.), is hard, and resists corrosion. Unfortunately, tungsten has proved difficult to machine in the usual way.

In the Bureau of Standards procedure, the item to be coated is heated—preferably to about 650° C., although any temperature between 300° and 900° C. is permissible—in a hydrogen atmosphere before the tungsten is deposited on the surface from a mixture of hydrogen and tungsten hexafluoride. (The hydrogen fluoride produced by the reaction is drawn off into a trap.)

Satisfactory adhesion to nickel, molybdenum and ceramics is reported. Copper does not bond as well and iron very weakly. If the object to be coated or formed is intricately shaped, the gases can be directed on it from different angles through an enveloping system of pipes. The hard coating obtained with this vapour deposition process is claimed to be less porous than any produced by other methods and purer than the commercial metal.

Supporting neighbours

BUILDING in cities to make the best use of expensive land can involve below-ground problems whose solution makes the work above pavement level seem comparatively trivial. New buildings often rise between neighbouring structures which can be a hundred years old and the operations necessary to ensure the older buildings' continuing stability can be almost dental in their approach and exactitude.

Some of the difficulty derives from lack of knowledge of allowable settlements in tall buildings: only in the last fifteen to twenty years have engineering records been kept which provide any means of enlightenment. In 1956, a survey by Professor Skempton of actual settlements in 98 buildings throughout the world showed settlements ranging from 1/10 in. to a hair-raising 28 in. Added to this is the growing effect on existing buildings of heavier traffic shuddering the frontages and the subterranean gnawing of the multiplicity of modern service mains.

Foundation engineering is not a new science, but its applications are transferring more and more from their prototype use on mine-shafts and tunnels to this need of a new building to support its neighbours. An example of this is a new block of luxury flats in Great Cumberland Place (architects, Manning and Clamp). The site was cleared and neighbouring buildings and roads needed more visible means of support. The block was required by LCC regulations to have one floor of basement and the soil was bad gravel and sand on top of clay at a depth of 30 ft. To build only one basement would have meant founding the building on expensive piles, and the consulting engineers

SCIENCE IN INDUSTRY *continued*

(Jenkins and Potter, Great Turnstile) therefore decided to construct three basements which could be founded on concrete pads in the clay. This provided a bonus of comparatively cheap space—which will be used to park 250 cars instead of the LCC's stipulated 74—but added to the problem of supporting roads on two sides of the site and buildings on the other two sides. One of these old buildings presented a 60-ft. expanse of sheer wall one foot out of plumb.

Conventional methods of underpinning, still in common use on most sites, would have meant propping and then casting concrete pillars about 4 ft. wide by 6 ft. deep along the length of the basement wall and then repeating the process three times to reach the necessary depth. A soils expert, Dr. H. Golder, suggested chemical grouting to consolidate the gravel under the neighbouring structures. One method, the injection of sodium silicate followed by calcium chloride, was rejected because of some doubt about its full penetration to the area required. The choice fell on the Cementation Company's so-called TDM mixture, consisting of two chemicals whose identity is hidden in the abbreviated name; the setting time of the new foundation depends on the proportions of chemical used.

The construction system meant boring piles and dropping in 33-ft. long rolled steel joists concreted up to 10 ft. of their length. Large voids in the shaly gravel behind were filled with a cement grout and then TDM was injected between the top of the joists and the footings of the adjoining building. The resulting bed of sandstone gave the contractors opportunity to carry on works undisturbed by a cumbersome underpinning process. The system leads to substantial economies in materials and time on foundation work and wall design.

Wind, wet, sun and motor cars

WHILE the British motor industry is building a wind tunnel in the interests of improving the stability of motor cars on the road, the Americans have put into use a weather tunnel in which complete cars can be subjected to extremes of temperature and humidity and to high head winds. This tunnel is not big enough to permit the yawing of a car to test side loads imposed by the wind without creating an unacceptable "blockage factor"; the British tunnel, which should be finished in three months, is designed to allow effective yawing.

The weather tunnel, made at Dearborn by the Ford company, can produce wind strengths of 125 mph with gusts up to 140 mph; it can vary the temperature from -20°F . to 160°F .; and it can produce rainstorms of all kinds from the normal to the tropical and monsoon type. The humidity can be varied between nil and 95 per cent. Doors, windows, windscreens and wipers, ventilation and defrosting can thus be tested in widely differing conditions.

Tests of this kind are normally made individually on motor car parts and components in this country in the process of design and development but there is no provision for putting the whole car through the complete weathering trial. The tunnel nearing completion at the Motor Industry Research Association's headquarters near Nuneaton, represents the British view of the prior importance of stability and reduced drag in motor car design.

Scientific Management Control

THE MORE COMPLEX business methods become, the greater the need for strengthened management control. Of course, it could be said that *all* management in this highly industrialised year of grace has to be 'scientific'. But it is really a question of degree: there are still many managers who find themselves obliged to make decisions without the assistance of deductions drawn from clear and complete factual information.

The role of an electronic computer. Science has done much to improve the techniques of manufacture and distribution but has so far done little to provide equally progressive methods of adequate control. However, this is where the electronic computer can now play an increasingly important part. The volume and complexity of figure work and the 'immediate' information required by modern business do not present such a formidable problem when dealt with by a computer—with its facilities for storing data, its speed in the handling of such data and the presentation of reports in readily assimilable form.

More time for planning. A business or factory with a computer can collect, store and quickly correlate all the data which has a bearing, for instance, on production. As long as the data supplied is kept up-to-date, this means that management executives always have the latest control figures in their hands, so giving them more time in which to plan future policy—time which otherwise might have been spent in waiting for essential information. For management control becomes truly scientific when its decisions are not only based on proper appreciation of all the relevant factors involved, but are made in good time so that they can be more effectively carried out.

We in I.C.T. realise the need for continuous study into management requirements; for the more we can understand them, the better we can bring the computer into action as an aid to management. And because of our constant examination of computer applications and techniques, we are not only manufacturers of reliable and successful equipment, but also specialists in the use of data processing equipment to assist and promote scientific management control.



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THE punsters must be pleased. Next year Sir Harold Roxbee Cox is to become chairman of the Metal Box Company. At once the image is conjured up of a new dual personality, an authentic Cox-and-Box. Box is the business tycoon, the head of a large expanding company; Cox is the newly appointed Chairman of the National Council of Technological Awards, the Vice-Chairman of the Air Registration Board, the Vice-Chairman of the College of Aeronautics, the influential link between science and its application. Perhaps there is a third figure, the amiable, lucid, sociable Rox—but enough.

Roxbee Cox is, in fact, a scientist turned administrator and industrialist who has had an impact in several different fields. Long ago he was a structural and aerodynamic engineer on the ill-fated airship, R101; later on he did much to tackle the problem of flutter in aircraft and was largely responsible for the wing stiffness criteria which are still used a generation later. Then he acted as midwife to Whittle's jet engine; after the war he initiated some interesting research at the Ministry of Power; and more recently he has had as much as anyone to do with the successful progress of the Dip. Tech. scheme.

To all this work he has brought a number of qualities that are not rare in themselves but which are comparatively rarely found together. He is first of all highly accomplished; he is very quick on a point; vigorous; an excellent expositor and advocate; self-confident; an able scientist and mathematician; widely knowledgeable; and the possessor of a sense of humour. One would guess that he takes life, and the way in which he has done well in it, without strain—not effortlessly, but without undue introspection. He is, in short, a *doer*.

Harold Roxbee Cox was born in Birmingham in 1902. He went to an excellent grammar school, King's Norton, and showed himself to be very capable at science, other than chemistry, and mathematics. He finished top of his form every term that he was there, and was well and widely taught.

From an early age he was interested in aeronautics. Those were the true pioneering days of flight, and there were great thrills to be seen. The young boy saw Graham White land at Bournville some fifty years ago, and went eagerly to flying exhibitions. Although preparing for the university, quite suddenly at the age of sixteen he left school and got a job in the aeroplane drawing office of the Austin Motor Company. In those days Austin's made aircraft, and Roxbee Cox worked on the design of the Whippet and the Kestrel. In his spare time he took a London external BSc in engineering with first class honours. In 1922 he went to Imperial College, where he gained a scholarship and spent a year on the post-graduate course and another on physico-mathematical research on fluid flow.

In 1924 he went to Cardington to work under Colonel Richmond on the construction of the R101. Despite the ultimate disaster, the years which followed still represent to Roxbee Cox, a self-confessed romantic, the most thrilling job on which he has ever worked. The vision of these great craft spanning the Empire stirred people's imagination, and the technical problems were absorbing.

PROFILE

Sir Harold Roxbee

Scientist, industrialist, administrator

Roxbee Cox started on the aerodynamic side. He worked on the external shape of the airship and the aerodynamics of its flight, and from this moved on to structural problems. Working with J. F. Baker, Alfred Pugsley and Miss Hilda Lyon, he did some notable work on the immensely complicated structure of the R101, and he was awarded the R38 Memorial Prize for his long paper on it.

In 1929, when the design had been completed, Roxbee Cox left Cardington for Farnborough. Then came the holocaust and in 1931 he returned for a time to the Royal Airship Works as chief technical officer; but the cause of the airship had been killed by the mysterious disaster to R101. He soon returned to Farnborough.

In the next few years Roxbee Cox did some skilful and advanced mathematics on the theory of structures and made some interesting contributions to the proceedings of the London Mathematical Society. His interest in the problems of airworthiness also developed, and, with his old friend and colleague Pugsley (now Sir Alfred) he tackled the airworthiness questions of wing flutter, which was the cause of many accidents to aircraft in the early 1930s. A thorough understanding of the problem was achieved, and Roxbee Cox's stiffness criteria emphasized that stiffness was as much a factor as strength.

From 1935 to 1938, still at Farnborough, he worked once more on aerodynamics and finally on air defence problems. In 1938 he joined the Air Registration Board as its first chief technical officer. He had much to do with the setting up of its organization for assessing the safety of aeroplanes. When the war came he returned to Farnborough as Superintendent of Scientific Research, and next became Deputy Director of Scientific Research at the Ministry of Aircraft Production.

This was an enthralling period. For the first part of it Lord Beaverbrook was in charge of the Ministry and dynamism was the order of the day. Roxbee Cox was actively concerned in getting the glider programme under way; but more important still was his role in the development of the jet engine. It was he who had to explain its

Cox



principles and possibilities to a Lord Beaverbrook whose reactions were rarely predictable. He did so successfully, emerged with *carte blanche* for the project and took charge of its administration, becoming Director of Special Projects at the Ministry in 1943.

There was an enormous amount of opposition to be overcome from entrenched interests before the scheme got under way, and a great deal of tact was called for from Roxbee Cox. He got on well with Whittle, for whose great gifts he has always had high admiration, and used his considerable powers of persuasion and committee technique in support of the inventor. In 1944 he became Chairman and Managing Director of Power Jets (Research and Development) Ltd., which was set up to develop the gas turbine, and in 1946 he was in charge of its conversion into the National Gas Turbine Establishment, of which he became the first Director. It was by no means an easy period, for the company was forbidden to make its own engines, and Whittle was bitterly disappointed at the course things took. So, perhaps, was Roxbee Cox, but he loyally did his duty, recognizing, even, that the ultimate dispersal of the brilliant team which had been working on the jet engine was probably necessary in the interests of the engine industry as a whole.

He got the NGTE running, and in 1948 transferred to the Ministry of Fuel and Power as Chief Scientist. He advised a succession of Ministers on the scientific aspects of the problems of the day, and as the Ministry had a freedom to initiate research which has since been denied to it, he started off a number of promising schemes. He kept up his interest in jets by initiating some research on industrial gas turbines, especially on engines running on low calorific value gas. He was in charge of the design and construction of the heat pump for the 1951 Festival of Britain Exhibition on the South Bank. He took an interest in windpower and its possibilities. He also initiated great steps forward in the underground gasification of coal and in the synthesis of oil from coal—a project which is still under development. In addition there were the problems of safety, especially in the mines. He was helped by having direct access to each of the Ministers under whom he served—in each case happily.

By 1954, however, he felt that the scope for promotion was limited, and decided to accept an invitation to go into industry as a director of Wilmot Breeden. In 1957 he became a director of the Metal Box Company and a year later joined the board of Boulton Paul Aircraft Ltd. Last year it was announced that he was to succeed Sir Robert Barlow as Chairman of Metal Box at the beginning of 1961, holding office as Deputy Chairman until then.

He has enjoyed his years in industry greatly. Besides the knowledge of science, of the management of science and of education (he used to lecture at Imperial College) which he has brought to it, he has been able to contribute both his balance and his vigour. He will say that on the face of it the product of the Metal Box Company—a tin, a plastic container or a cardboard box—is not particularly interesting, but that the mechanical engineering required to turn out, say, cans at the rate of 700 a minute can be fascinating; and so is the research, which covers microbiology as well as metallurgy, as well as the financial and commercial side. Since his early days Roxbee Cox has moved farther and farther from the specialist scientist or engineer, and today he is very much an all-rounder.

His all-roundness shows itself in a variety of other ways. His work as Vice-Chairman and Chairman of the Executive Committee of the Hives Council has been nationally important. Lord Hives provided inspiration and his great authority, but Roxbee Cox has had an enormous amount to do with putting the plan into effect. His work on airworthiness through the Air Registration Board's Council has been far from nominal, and he has also been until recently Chairman of the Civil Aircraft Research Committee and is still a member of the Council for Scientific and Industrial Research and the Naval Education Advisory Committee.

Happily married, with two sons and a grandchild, Roxbee Cox lives near Regent's Park. He has an unusual collection of aeronautical prints, including some rare prints of balloons. He reads widely, enjoys the theatre, has a very quick sense of humour and a weakness for the Flook cartoon in the *Daily Mail*. He is, in short, as lively and receptive in his private life as he is in his public and business activities.

AMERICAN NEWSLETTER

*Pioneer V: a saner perspective**from JOHN LEAR, our American correspondent*

WASHINGTON. THE most important thing about the new man-made planet that is now on its way toward the orbit of Venus has not been mentioned in any of the news reports I have read or heard.

It is the attainment of a reasonable sense of perspective.

For the first time since *Sputnik 1* frightened a provincial and conceited people, a major American venture in the exploration of interplanetary space was undertaken without bombast or hysteria.

No sensational objective was invented to justify the \$12-14 million expenditure of tax moneys on *Pioneer V*.

No pretence was made that some incredible new spy or weapon system was involved to save the world for democracy.

No political advantage for either the party in power or the party out of power was trumpeted.

No real or imagined target was set up to be hit.

It wasn't even claimed that *Pioneer V* was going anywhere in particular.

A scientific experiment was initiated with all the risks of possible failure normally attendant on scientific experiments—and that was that, as it ought to be.

Pioneer V was simply going out to look around and report back whatever new it might discover.

The tiny planet might be able to make itself heard across 20 million miles. It might speak across 50 million miles. Though everyone hoped for the most, the distance wasn't the crucial element. What really mattered was the capability of *Pioneer V*'s radio transmitters to get clear signals back through the magnetic and electrified gas storms that boil the atmosphere of the Sun.

Until intelligent communication can be assured, it is a waste of time, energy and money even to contemplate sending instrumented vehicles on exploratory missions to the actual planets of Venus or Mars. At this stage of the art of telemetry, it is far from certain that

interplanetary forces yet only dimly understood will not destroy some or all of the 4,800 solar cells that catch and transform sunlight into power for *Pioneer V*'s instruments—or that powerful bursts of radiation from the Sun will not silence the broadcasting oscillators or distort the coded information stored on the planetoid's magnetic recording tape. The voyage of *Pioneer V* is therefore only a probing excursion, and no one has called it more.

Since others have failed to do so, I want to congratulate the National Aeronautics and Space Administration Chief, a scientist, Dr. Keith Glennan, on the final bringing about of what he has been striving for ever since he took office: the consideration of space as merely another environment in which appropriate scientific research can be conducted.

It was a stroke of genius to begin the *Pioneer V* experiment at a time when Venus lay on the other side of the Sun, when there was no remotely reasonable possibility for sensation-minded columnists or profit-seeking publicity men of the rocket makers to seize upon and exploit it into a Venutian jaunt. Even the most versatile high-speed computer now in being, given months of time in which to calculate successive orbits of Venus and of *Pioneer V*, would be helpless to say whether the new man-made planet, in swinging around the ellipse it appears to be starting between the orbits of Earth and Venus, will ever encounter Venus no matter how long *Pioneer V* survives in space. The mathematics of such a question are known as "a four body problem". A four body problem has never yet been solved in advance. The pull of the Sun's gravity, the pull of the Earth's gravity and the pull of Venutian gravity—all must be figured into the equations. The best that astronomers can do at present is to guess that *Pioneer V*'s closest approach to Earth in the next decade will be several hundred thousand miles, and that the chance of the planetoid being captured and incinerated by Earth's

atmosphere is about one in 100,000 years. Rather than being closely predictable, *Pioneer V* is very likely to predict through its behaviour other heavenly phenomena now tracked only approximately.

As I write this letter in the early hours of Sunday afternoon, NASA reports that the new planet's messages are coming in strongly. The solar cells are charging the mercury storage batteries inside the 26-inch ball "even better than expected". But the truly exacting test of *Pioneer V*'s value is yet far off. The smaller of the planet's two radios, a five-watt, is responding to commands from the ground at frequent intervals. If all goes well, this will continue for the first million miles or so of the outgoing voyage. Not until signals from the five-watt begin to dim will the second radio, with a power of 150 watts, be called upon to take over the task of speaking across the vaster distances, perhaps as far out as 50 million miles from Earth, the distance of Venus's orbit on 8 August. For the sake of perspective, it is well to keep in mind that the longest broadcasts from space to date were made by *Pioneer IV*, whose messages faded and were lost beyond 407,000 miles.

There are still not enough skilled science writers in this country to fit the pieces of the *Pioneer V* story together as they ought to be put for the clear understanding of American newspaper readers. But what has been reported is altogether pervaded by the saner perspective here emphasized. Nowhere is this new point of view more evident than in references to the fact that the radio-telescope at Jodrell Bank not only sent the message releasing *Pioneer V* from its carrier rocket, but will be the sole source of contact with the new planet in the farther reaches of travel. There were no long-winded explanations of why America doesn't have such a powerful instrument. There was instead a tacit acceptance of the notion that the exploration of space is too big a job for any one people.

*In the heart of the Ashdown Forest.*

THE FUTURE OF COMMONS

Commons occupy an area of England and Wales little less than that used for houses and gardens. But there is widespread deterioration in these last reserves of uncommitted land and urgent need to conserve them as open-air laboratories, grazings and places of recreation

by GARTH CHRISTIAN

EASTER holiday-makers who wander on the heaths of the English lowlands, perhaps hopeful of finding a few resident stonechats or early spring migrants, may often be dismayed at what they see. March, April and May form the main season for common fires. Every year one hears of odd pairs of the rare Dartford warblers—still holding their own in Hampshire—or the more familiar visiting whinchats banished from their territories by fires which in many cases are deliberately started, and which cost ratepayers in some southern counties more than £3,000 a year.

Undergrazed commons which escape the fires may grow into impenetrable thickets, the refuge of woodpigeons—and of the jays and magpies which destroy 80 per cent. of the woodpigeons' eggs—but of little interest to the naturalist. Where grazing or fires keep down the scrub, picnickers and local builders may treat the common as a dump for their litter.

No wonder there is impatience among members of both Houses of Parliament

*Dartford warbler.*

who wish the Government to implement the recommendations of the Royal Commission on Common Land, which reported in July, 1958. Seven months later the Government accepted a motion in the House of Commons welcoming the Report; but no hint was given on whether the Commission's proposals are to be introduced. Nor is this surprising to anyone who is aware of the tangled state of the laws relating to commons, many of which were ancient long before Parliament even existed. "If a Bill is ready by November, 1960," the Commission's Chairman, Sir Ivor Jennings, has said, "the Government will have shown unusual expedition."

There is a real danger that amid the spate of discussion about the legal and economic problems hindering the welfare of the last uncommitted areas of land in Britain the voice of the scientist may go unheard. The Royal Commission listened attentively to the complaints of commoners who, though not the owners of the heath, possess such traditional privileges as the right to

THE FUTURE OF COMMONS *continued**Whinchat alighting.**Stonechat.*

graze as many cattle, horses or sheep—or sometimes pigs, goats and geese—as they maintain on their own land in winter; and the Commission urged that a Commons Registration Authority, over a period of eight years, should record their claims to rights over the land. The Authority would receive, too, claims to title by owners of the soil, often the local Lord of the Manor, who enjoys the ordinary rights of ownership, limited only by the claims of the com-

moners to part of the natural produce of his acres, and by the statutory prohibitions against inclosure.

Yet though the Royal Commission readily accepted the Nature Conservancy's plea that common land should be preserved as a national reserve, to be used for many different purposes, their able Report largely ignores the scientific principles that should shape our treatment of the land. Little has been written about the need to maintain the

"biological capital" of the 1,500,000 acres of common land in England and Wales, whose neglect and mismanagement appear in many instances to be producing a sharp decline in the fertility of the soil. Nor is that all, for ecologists who explore these last natural reservoirs of the native flora and fauna cannot avoid a sense of concern at the dwindling numbers of plant and animal species.

A recent ecological survey of a typical Sussex common on Tunbridge Wells sand reveals how the decline of the farm horse, the coming of heavy road traffic beside the unfenced heath and the increasing abundance of stray dogs have been instrumental in producing a dramatic advance of bracken, *Pteridium aquilinum*, and other plant pests; and this trend has been matched by a decline in the population of stonechats, whinchats and the typical heath butterflies. The juniper, *Juniperus communis*, has vanished and so have some colonies of butterfly orchids, *Platanthera chlorantha*.

Fifty years ago nine commoners earned a living from these 380 acres, cutting the grass, gorse and bracken; today the gorse-cutters are as scarce as the declining wintergreen, *Pyrola minor* (which recently seems to have vanished from its old haunts in the Ashdown Forest). The prime cause of these changes in the abundance of wild fauna and the vegetation on which they depend can be traced to the absence of regular cutting and grazing. For this has led to the annual custom of burning much of the heath, with disastrous consequences for many uncommon bog

*Juniper.**Butterfly orchid.*

plants which are easily killed by fire.

Soon after each big blaze, it has been evident that the bracken was spreading at the expense of its scorched competitors. Up to 1954, grazing rabbits checked the advance of brambles and ling, *Calluna vulgaris*, as well as young seedlings of oak and other species, though they usually spared the less palatable silver birches. The destruction of rabbits by myxomatosis led to the growth of more scrub and outbreaks of bigger fires; and with too much burning and some human erosion shattering the stability of the natural heath plant community, ideal conditions were created for the spread of rosebay willow herb, *Epilobium angustifolium*, thistles, *Cirsium arvense*, and other weeds in place of more attractive species. Much the same tale could be told of many of these lowland heaths which are of considerable scientific value and can teach us much about the little understood problems of land management.

A rather different situation exists on the hill commons of the north and west supporting arctic-alpine vegetation. There soil erosion and a serious deterioration in the quality of the grasses frequently result from overgrazing. This, in turn, is the sequel to the collapse of the ancient system of land management controlled, perhaps, by the Customary Court of the Manor.

Our commons today occupy 4.03 per cent. of the total land surface (in Wales alone the figure is nearer 9 per cent.), which is little less than the area used for houses and gardens. With well over 35,000 acres of agricultural land claimed for urban development and other needs each year, it is hardly surprising that envious eyes are cast on the commons.

It is important, however, that before deciding on the best treatment for each common, the land should be classified according to its stability and structure, its capacity for retaining moisture, the fertility of the soil and the amount of grazing which the sward can endure without deteriorating. If the warning voice of the ecologist goes unheard, we may find more of the last surviving stretches of chalk grassland disappearing under the plough, though this treatment can produce a serious risk of soil erosion where the ground slopes steeply. More of this grassland would have been ploughed long ago had it not been held "in common".

Elsewhere hasty conversion of heathland to food production has sometimes

proved so unprofitable that it has been abandoned. Land formerly cultivated which adjoins the 150 acres of Midhurst Common in West Sussex is now hardly distinguishable from the unploughed common land. Flooding, dwindling reserves of water and the advance of plant and animal pests may be the reward of those who seek quick and easy profits from heathland while forgetting that the soil is often the poorest in the neighbourhood.

During the last War, however, when 21,000 acres of common land were requisitioned for food production, splendid crops were sometimes harvested. The Royal Commission was told of a hill in Central Wales which yielded 23 cwt. of oats to the acre and 11 tons of potatoes, this on land 1,300 feet high which formerly grew only bracken. Now that research is teaching us so much more about the wise management of grassland, none can doubt that many stretches of common land could make a far bigger contribution to the nation's diet.

There are many areas, too, which might well yield fair crops of timber

if access by the public could temporarily be restricted while the trees are young. Small plots of woodland at high altitudes have been shown to benefit the grass and the grazing stock by providing valuable shelter. While few hardwoods grow well on stretches of heath such as the 6,400 acres of the Ashdown Forest, there is a case for planting softwoods, perhaps protected by the native silver birches which add so much to the beauty of the scene. The limestone grasslands of the north are normally too useful as grazing areas to be exploited by the forester; but the barren limestone pavements on such commons as Ingleborough Fell, Yorkshire, might well produce good shelter belts that would nurse the attractive native shrubs and herbs.

The forester, like the arable farmer, often finds himself competing with the rambler who values our commons for their wildness and loneliness. For not all heaths are like Burnham Beeches, where 400 cars may be parked on a fine Sunday in high summer. With more than two-thirds of the South Downs in East Sussex under the plough, areas like the



Common land in the New Forest.

THE FUTURE OF COMMONS *continued*

Ashdown Forest, where a thousand or more commoners claim the right to cut the bracken, lop the branches or graze their stock on the grass produced from Earl De La Warr's soil, may be the only ground for miles around where the visitor can wander through a semi-natural landscape. Every part of Britain needs its wild places where the call of the curlew and the song of the stonechat greet the visitor from the city.

This point must never be forgotten. The Forestry Commission recently revealed a growing awareness of the fact when it agreed not to plant any more trees on 300 square miles of land in the middle of the Lake District; and this action should be remembered by those who will probably protest if the Commission is granted leave to plant small parish forests—perhaps to be handed over later to the local authority—on certain stretches of common land.

In recent years far too many commons have been spoilt by the failure to recognize their scientific value as the haunt of rare plant and animal communities that have disappeared from the rest of the neighbourhood. In 1940, for example, the local Agricultural Executive Committee arranged with Quy Parish Council, Cambridgeshire, to let the Poor's Fen for grazing. An enterprising farmer persuaded the Trustees, drawn from three local councils, to permit the ploughing and reseedling of the area; and in a matter of days one of the last relics of rough-grazed "fen margin" land in Cambridgeshire, with rich plant communities around some abandoned coprolite pits, was irreparably damaged. After protests, the ground was reseeded, but only remnants of the original plant community remain.

Happier, thanks to the Nature Conservancy, was the fate of Port Meadow, Oxford, where the commoners were ordered to sacrifice some of their grass for King Charles's Cavalry during the Civil War. The plant association results from the annual grazing of the commoners' stock through at least nine successive centuries; and it would have been disastrous if the City Council had carried out its decision, in June, 1955, to spray 80 acres with the selective weed-killer 2,4-D in order to get rid of ragwort and thistles. Fortunately, ecologists of the Nature Conservancy and the Ministry of Agriculture, Fisheries and Food discovered what was about to happen and persuaded the authorities to cut and burn the weeds.

Typical of what might occur else-



On Ilkley Moor.

where is the fate of Flordon Common, Norfolk, a heath which was well known for its rare flowers. In recent years a farmer was permitted to drain and plough part of it; whereupon the Commons, Open Spaces and Footpaths Preservation Society supported a proposal for the purchase of the manorial right by the local rural district council, who would lease the cultivated area to the farmer, reserve another section of the heath as grazing land for the commoners and maintain one corner as a small Nature reserve.

Perhaps a similar approach is needed when framing the management plan for many other commons. Farmer and forester, sportsman and Rambler, Territorial and naturalist—all have a stake in the welfare of these last reserves of uncommitted land. The Nature Conservancy, which would rightly oppose the reclamation of the 200 heaths scheduled

as Sites of Special Scientific Interest, has launched three "shadow" schemes covering Hartlebury Common, Worcestershire, and other heaths, in the hope of gaining useful experience in the management of a common that is shared by various users.

When seeking to reconcile the competing claims of many conflicting interests, and after the scientists have assessed the biological potentialities of each common, we should be wise not to forget their value as open-air laboratories where much remains to be discovered about the highly complex techniques of land management. Common lands which are built on disappear forever. Commons that are treasured as well-managed grazing land, picnic sites and Nature reserves may have much to reveal to the citizens of tomorrow.

(Commons photographs by the author; birds by Eric Hosking.)

THE SHAPE OF GEAR TEETH

A new design of tooth geometry for gears, recently developed in Russia, is claimed to carry three to four times the load of conventional gears of the same size. There are production difficulties to overcome, but the system shows high promise, especially for industrial power transmission

by G. B. THOMPSON

Associated Electrical Industries (Rugby) Ltd.

THE majority of machines on which modern industry depends use gears in one form or another. Any development which promises to reduce the size and cost of gearing is thus of considerable importance and worth detailed investigation.

In the past few years there has been growing interest, particularly in Russia, in a type of gearing which has come to be known by the name of its Soviet discoverer, M. L. Novikov. The same system was originally proposed some twenty years earlier by an American, E. Wildhaber, in 1923, but it remained undeveloped. The Russians devoted a big programme to developing the new

gearing system, and now claim that it can carry three to four times the load of a conventional spur gear of the same size.

To understand why this should be so, we shall have to examine the limitations of the simple spur gear, shown in Figure 1. The purpose of gearing of this sort is to transmit motion from one shaft to another which is parallel to the first. Sometimes the purpose of the gearing is to change the angular velocity, and the driven shaft may move faster or slower, according to the gear ratio, than the driving shaft. But whatever the ratio may be, one essential is that it shall remain constant as the driving shaft re-

volves. In other words, if the driving shaft is rotating at uniform speed, the driven shaft also must rotate at uniform speed.

This relationship is normally brought about by the geometry of the intermeshing teeth. The teeth make contact with one another along a line stretching the width of the wheel, and the load is transmitted from wheel to wheel over this area. As the gearing turns, the position of the contact line changes, starting near the root of the driving tooth and the tip of the driven one, and ending near the tip of the driving tooth and root of the driven one. It can be shown by simple geometry that if the gearing is to transmit a constant ratio, then the shape of teeth must be arranged so that the common normal to the teeth surfaces at the point of contact always passes through the same point (Figure 2). If this condition is fulfilled, the tooth shapes are said to be "conjugate".

The point through which the normal to the tooth surfaces at the contact always passes is on the line joining the axes of rotation of the two shafts. It is called the pitch point. The two circles drawn with the axes of the two shafts as centres are called the pitch circles. The gears transmit motion from one shaft to the other as though they were two toothless friction wheels in contact at the pitch point and of diameter equal to the pitch circles.

The load, as we have seen, is transmitted from tooth to tooth through what is virtually a line contact. The maximum load the gears can carry is limited in two ways. First, there is a tendency, particularly when the load is applied to the tip, for the tooth to snap off at its root, and the stresses in the tooth roots must obviously be kept below this value. Secondly, the surface of the metal in the region of the line contact will be very heavily loaded, and this load

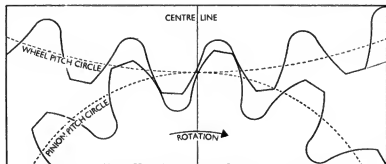


FIGURE 1. Tooth engagement between two involute gears.

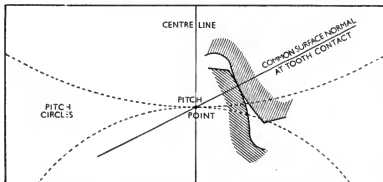


FIGURE 2. Conditions for gear teeth to be conjugate.

THE SHAPE OF GEAR TEETH *continued*

must be kept below the maximum which the metal will withstand.

In gears made from unhardened steels, surface stress at the region of contact is by far the most important. It depends on the applied load, the elastic properties of the materials used and the curvatures of the two surfaces. The shape of the curved tooth surfaces in contact has a twofold effect. First, ignoring the effect of any oil film which helps to spread the load, shape largely defines stress distribution. If the difference in curvature is very marked, the area of effective contact will be smaller: if the difference is smaller, the contact area will be larger. Secondly, the thickness of the film of lubricant between the teeth depends on the shape of the curved region close to the area of contact, and this modifies the stress distribution over the two surfaces.

So in order to improve the load-carrying capacity of gears, engineers can either improve the materials they use or attempt to find a tooth geometry which is more favourable. The customary tooth shape is the involute. Involute gears are conjugate, and the tooth shape on the driving and driven wheels can be generated with the same tool, which is advantageous in simplifying production. Many engineers have attempted to find better tooth shapes, but without success. The reason was pointed out by Euler and Savari, two eighteenth-century mathematicians, who were able to show that any pair of conjugate teeth had very similar differences in curvature near the contact region. Changing the shape of the gear teeth would thus not be expected to bring about any great improvement in their load-carrying capacity.

But this restriction applies only to conjugate tooth shapes. The Wildhaber-Novikov tooth shapes are not conjugate. The profiles of the teeth fit together—one being a convex and the other a concave arc—so that there is almost no difference in the curvature between them. The two teeth profiles are circular, so that they fit together only at one position, when the normal to the surfaces passes through the pitch point. This condition is shown in Figure 3b.

Suppose the two gears in Figure 3 were each driven uniformly at speeds of the appropriate ratio. When the teeth reach the position shown in Figure 3b their surfaces will mate and contact one another. But a moment before (Figure 3a) or after (Figure 3c) this position the teeth will not be in contact.

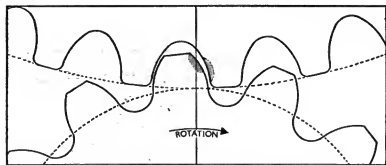


FIGURE 3 (a). Mating faces approaching one another.

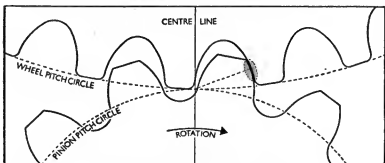


FIGURE 3 (b). Moment of contact.

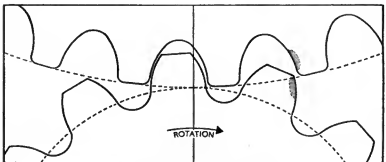


FIGURE 3 (c). The faces separate.

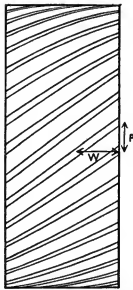


FIGURE 4. A helical gear. If the teeth are of Wildhaber-Novikov design there is only a single area of contact on any one tooth in the width W . The contact areas move across the teeth from side to side of the gear as it turns.

Now think of the pair of gears twisted to form a helix. One of the gears is shown diagrammatically in Figure 4, and the way they fit together can be seen in the photograph (Figure 5). The helical gears are equivalent to a whole series of thin spur gears each displaced slightly with respect to its neighbours. In a width W of the helical gear (Figure 4), the amount by which any tooth is twisted is equal to the distance between two teeth P . If we think of all the individual thin spur gear pairs driven at uniform speed which make up the width W , one of them, and only one, will be in the position where the teeth mate exactly. In other words, the pair of helical Wildhaber-Novikov gears are in contact in one region only for each width W .

As the gears turn, the contact regions move across the teeth. Although the gearing is not conjugate in the usual sense, notice that all the contact regions fulfil the conditions. Because of the width of the gears each of the component "spur gears" is driven at uniform

speed by the others. Only when its mating surfaces are in contact does any individual component spur gear momentarily take part in carrying the load.

This idea neatly circumvents the Euler-Savari limitation on designing tooth profiles to give lower surface stresses. The contact area of the load-carrying surfaces can be made large by suitably designing the teeth, and hence the surface stress produced by a given load can be made smaller. Under load the contact area is an ellipse.

This system of gearing thus has in theory a much greater load-carrying capacity, for a given maximum surface stress, than conventional gearing. But it has certain practical limitations. In involute gearing the distance between the centres of the revolving shaft can vary appreciably without disturbing the ability of the gears to function properly. This is invaluable in practice because errors both in the gears and in the gear-box are bound to arise during manufacture.

The Wildhaber-Novikov system, however, achieves its maximum load-carrying capacity only when the profiles of the two gears fit together exactly. This allows no tolerance whatsoever in the distance between shaft centres mounted in the gear box. Even if the gears could be manufactured and assembled perfectly, the bending of the loaded gear teeth would prevent the perfect conformity of the tooth profiles when they come together.

Both difficulties can be overcome by mismatching the two engaging profiles, as shown in Figure 6. The radius of curvature of the concave tooth is made larger than that of the convex. The larger the difference between the two, the greater the inherent tolerance to errors in the manufacturing process. As the centre distance is changed, the point of contact moves up or down the profile, but the contact conditions remain much the same.

Because of the mismatch between the teeth, the contact is now reduced to a point. However, when transmitting a load the elastic properties of the teeth spread the point contact into an area. The bigger the mismatch, the less accuracy is needed in making the gears and gear-box, but the smaller the contact area and the lower the load which can be carried for a given maximum surface stress.

It can be shown from Hertz's analysis of elastic contact that the amount of profile mismatch needed to accommo-



FIGURE 5. Wildhaber-Novikov type gears designed for high load duty.

date the errors which are usual in gearing manufacture reduces considerably the load that can be carried. Wildhaber-Novikov gears must be made more accurately than the ordinary involute gearing if advantage is to be taken of their improved load-carrying capacity. The designer, in choosing the degree of

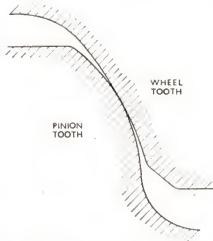


FIGURE 6. Mismatch between pinion and wheel tooth profiles. This permits the depth of tooth engagement to be varied slightly, so allowing for manufacturing tolerances.

mismatch, must take into account the expected errors in the whole manufacturing process from the making of the gear-cutting tools to the final assembly of the gear-box.

Fortunately, there are effects which tend to offset the difficulties of making the gears sufficiently accurately. If a pair of gears is to engage satisfactorily they must start with some degree of profile mismatch. But after running for a time the local plastic flow of metal in the tooth surfaces will reduce the difference in curvature, and thus increase the load which can be safely carried.

Lubrication, too, helps greatly. Calculations of the expected oil film thickness at contact in a gear-box we designed showed that it should be more than twice that expected in similar involute gears. There are two reasons for this. First, the small difference in curvature near the contact area favours the establishment of a thick oil film. Secondly, the rapid movement of the "wedge" formed by the contact area across the tooth surface from side to side of the gear produces a strong "pumping" action.

The Wildhaber-Novikov gears are made by the same processes as are used for involute gears, although separate tools are required for cutting the concave and convex tooth profiles. For this reason, and because greater accuracy is needed, the gears are likely to be rather more costly to produce than conventional kinds of a similar size. Design studies suggest that this disadvantage may be outweighed by the greater load that the Wildhaber-Novikov gears can carry.

Indeed, the system seems to have a potentially useful future for highly-loaded drives working at medium and low speeds. According to Russian sources the efficiency is comparable to if not better than that of an equivalent involute gear-box. At high speeds, however, the high lubricant velocities developed along the gear teeth (pumping effect) may well introduce some reduction in efficiency.

The success or failure of the system will depend on manufacturing techniques. If the production difficulties can be overcome it may prove a serious competitor to conventional gearing, especially for industrial power transmission.

The author wishes to thank his colleagues in the Rugby and Aldermaston Research Laboratories of AEI for their help and encouragement.

IT SEEMS TO ME

by GEMINUS

THE rocket towards Venus is an excellent instrument, and its launching should still further help to persuade the Americans that the careful planning of a few experiments in space is preferable to a rapid succession of rockets sent somewhere into space. Now that the hullabaloo of the first few months of space research with satellites has died down, it is time to reflect that it will be decades at least before the surface of this new field of research is even scratched. (British astronauts please mark well and digest.)

In this light the merit of the latest rocket is that it is an important experiment in long-distance communications. If the higher-powered transmitters work well enough for information to be collected from up to 50 million miles away, it is fair to expect that very similar techniques will suffice to establish communications over the whole of the inner solar system—between any two points within the orbit of Mars, for instance.

For the radio telescope being built at Greenbank, in Virginia, should be able to pick up identical signals out to a range of at least 120 million miles. Clearly it is not unreasonable to expect that the next space rocket could be equipped with a transmitter with a power four times as great as that of the present one, even if this meant adding more solar batteries or alternatively reducing the period of transmission at the most distant ranges to a few minutes every day. This would mean that the Greenbank telescope would be able to pick up these transmissions out to a distance of 250 million miles.

But if the problem of communications has been solved, it is clear that a great deal remains to be done before rockets can be launched with sufficient accuracy for them to travel accurately along pre-planned orbits of this extent. Yet it would be unreasonable to expect that there should be any dramatic improvement in the accuracy with which rockets can be guided through their launching phase. It follows, I think, that the next step forward in rocket technology must be the development of techniques which can orientate packages of instruments accurately in space, and which can then arrange that a rocket which is off its course can be given an extra burst of power whenever the watchers on the ground think this to be needed. Only in this way will a land-fall on Venus be made in the next few years.

IT is curious how quickly official attitudes are eroded with the passage of time. Some time ago—at the time of the *Daily Mail* air race from London to Paris—I was taken to task by certain people from BEA for having clamoured for a more sensible way of running the normal air service from London to Paris, and in particular for the facility to turn up at the airport and buy a ticket just as if one were catching a bus. It would all be impracticable, I was told, and people would spend needless hours waiting for a seat. It is odd, therefore, that the chief executive of BEA was not overcome with these doubts when he announced the other day that it was hoped to introduce on domestic routes the kind of system I had been asking for, and that later this would probably be extended to the London and Paris route.

Then there is the question of tariffs of telephone charges. Soon after Christmas the Post Office wrote to *The New Scientist* to say that the present system was soundly based on economics and on experience, and that I was foolish to be clamouring for a change. So I was naturally surprised to hear the Postmaster-General say, in an after-dinner speech a few days later, that the present system of tariffs was not "sacrosanct".

My purpose in raking up this mud is not to show that in the end everybody is converted to my opinion. Instead, I want to draw attention to the way in which apparently expert knowledge has been used to argue that reform is either impossible or undesirable—a practice which I consider to be one of the dangers attending the rapid spread of technical development throughout the national life. In these particular issues technical arguments have been used to defend positions the abandonment of which had already been prepared for at a higher level.

★

THE long walk from John o' Groats to Land's End has been well worth while for those of us who did not take part in it. Whether the same can be said on behalf of those who actually stayed the course is another matter. Somebody should ask them when they wake up.

One aspect of the affair demands more than passing attention, however. From the necessarily sketchy interviews con-

ducted on the way it seems that there has been no obvious correlation between success in the race and previous athletic experience. After the first few days it seemed that the task was not so much that of using bodily fitness to move a little faster, but rather of using reserves of psychic morale to keep the feet moving at all.

This, I suppose, is what one would expect. However, it does suggest a few measures that might sensibly be taken by walkers in any future races of this kind. The first thing to do would be to spend some days living a gay life in some tourist city. Then one would welcome the inevitable boredom of the walk. Towards the end of the journey boredom would become unwelcome. Then it would be time for the walker's assistants to give him the illusion that he was leading a normal life, and not walking at all. This is where a portable television set would be an excellent thing. Such a screen would be mounted at the back of a van travelling in front of the walker. For much of the day he could be regaled with the products of the television studios, and could from time to time make comparisons between the quality of independent television in different regions. Further, it needs only a little thought to show that the same principle could be used as a kind of electronic pacemaker. Only the faintest hearts would let the little glowing screen of warmth and light get out of sight.

★

WITH the resurgence of interest in oceanography it is becoming more and more apparent that facilities are needed for the systematic collection of more data about the oceans. In the long run this can be done only by means of more research ships, but in the meantime it seems to me that a great deal might be done by persuading commercial vessels to carry a few simple measuring instruments—continuously recording thermometers and hydrometers would be valuable, while the bigger ships might be encouraged to greater ambition. The fact that a similar scheme is already used by the Meteorological Office in the collection of simple atmospheric data from ocean-going vessels is a sign that this sort of thing can be done without too much interruption of the normal work of a ship. In fact, on modern ships some diversion of this kind for the crew is often welcomed.

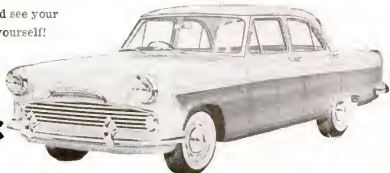


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Electrical Aids in Industry

Data Sheet No. 11

Dielectric Heating - 2

The ability of dielectric heating to generate heat through the mass of a suitable material provides the following considerable advantages over other heating methods.

1 A body of uniform section and composition is heated uniformly throughout. Hence there is no waiting for heat to be conducted to the centre of the body, and this is of particular advantage when the body is thick, and, as is often the case with dielectric materials, has poor heat-conducting properties.

2 The rate of heating can be faster than by external heating methods.

3 Since there is no external heat source, overheating or burning of the surface of a heat-sensitive material is avoided.

4 Heat input and heating time can be positively controlled.

5 High thermal efficiency is achieved.

6 Production can start immediately after switching on, and no current is used, nor heat lost, during periods of shut-down.

7 Vastly increased productivity is obtainable with less labour (usually unskilled), and fewer machines and less floor space are required.

8 Dielectric heating provides flexibility of layout and can be inserted directly in the production line.

Preheating Thermosetting Plastics

Dielectric heating is ideal for preheating pellets used for thermosetting plastic mouldings, which are poor heat conductors. It promotes faster curing, reduces moulding time, and can increase production 10 to 15 times. Tool wear and

damage to metal inserts are reduced, and thicker sections can be moulded.

DIELECTRIC HEATING
TYPICAL APPLICATION DATA

Typical application	Frequency	Radio frequency power
Thermoplastic welding	20-100 Mc.p.s.	Up to 1 kW
Plastic preheating, wood glazing	10-40 Mc.p.s.	2-30 kW
Plywood manufacture	2-10 Mc.p.s.	Above 30 kW

Note: 1 Mc.p.s. = 1,000,000 cycles per second.

Welding of Thermoplastic Materials

An important and extensive application of dielectric heating is the welding of thermoplastic sheets in the fabrication of such commonly used articles as raincoats, hoods, handbags, pouches and packaging materials. Dielectric heating is the only method which can usefully be employed, since the heating electrodes, and hence the outside sheet surfaces, remain cool while the inside surfaces forming the joint are fused, and a perfect weld results.

Two or more thermoplastic sheets are welded under pressure from electrodes suitably shaped to the area of weld required, the current being switched on at the same time as pressure is applied, and off when the weld is completed and the pressure released. Stitching is thus eliminated and a far stronger joint achieved.

In some cases, a suitably profiled electrode can be fitted with a knife edge to cut the sheets immediately outside the weld line, welding and pattern-cutting being thereby carried out in the one operation. Dielectric welding can be applied also to very large thermoplastic products such as linings for swimming pools, and cinema screens.

Drying

Drying of materials by dielectric heating has the great advantage that the material tends to dry out from the centre, the reverse of what happens when external heating methods are employed, and the risk of overdrying and overheating of the surface is eliminated. While the removal of large amounts of water from inexpensive commodities may sometimes be uneconomical, dielectric heating in the production line often leads to a higher overall production efficiency. It is valuable for removing final moisture traces and becomes increasingly economical as the value of heat-sensitivity of the commodity increases.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8.6 each, or 9.1 post free) are available — "Induction and Dielectric Heating" is an example.

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TRENDS AND DISCOVERIES

Inverse bubbles

IF a drop of a suitable solution of soap or detergent falls on to a surface of the same solution it can carry a spherical shell of air down with it beneath the surface. M. H. J. Baird, of Cambridge (*Transactions of the Faraday Society*, Vol. 56, p. 213), has studied the structure and stability of such "inverse bubbles".

The bubbles can be up to 2 cm. in diameter their average thickness is 5 microns (a two-thousandth of a centimetre), but is much less than this at the bottom and correspondingly greater at the top; and depending on size and other factors the lifetime of the bubbles can be up to 15 minutes. The shape of a bubble is determined by a balance between the weight of the inner liquid sphere which falls under gravity and the support given it by the upward flow of the displaced air. The thickness of the air at the bottom of the bubble decreases slowly with time, and when it falls to a value not less than about 0.3 microns there is coalescence between the inner and outer liquids.

The coalescence often occurs before the air film has become so thin, and probably takes place when distortions of the liquid surfaces, caused by mechanical or thermal shocks, allow the liquid to bridge the air gap.

Seaweed against coronaries

IT has been known for some time that the level of cholesterol and lipoprotein in the blood is raised in patients suffering from coronary thrombosis. Ways are being devised to lower blood cholesterol and lipids by purely chemical methods without recourse to dieting.

Heparin lowers both blood lipids and cholesterol, particularly if they are already high, but its cost is so prohibitive that it cannot be used continuously. Moreover it increases the clotting time of blood and increases the tendency to bleed. A number of synthetic substances related to heparin have been examined by P. Constantinescu, of Vancouver, to see if they exert a specific effect on blood cholesterol and lipids (*British Medical Journal*, Vol. 4, 1960, p. 535).

In tests on rats and rabbits the sulphated derivatives of certain seaweed compounds seemed to give the most promising lead. When a purified preparation ("paritol") of sulphated polymannuronides, obtained from seaweed, was given to patients with raised blood lipids and cholesterol, many of whom had recovered from an attack of

coronary thrombosis, the values returned to normal in one to three days without any effect on the blood-clotting mechanism. Paritol was, in fact, more effective than heparin at a fraction of the cost.

Blood-sugar curiosity

MOST animal tissues contain glucose as their main source of energy; nevertheless in most species, including humans, the foetal blood has fructose (another sugar) instead. D. G. Walker at the London Hospital (*Biochemical Journal*, Vol. 74, p. 287) has shown where the fructose is formed. Pregnant goats and sheep were used as experimental animals.

The results indicate that the fructose is formed from the glucose of foetal blood, in the placenta. Once the fructose is formed, it cannot pass into the mother's blood as the placenta acts as an impermeable barrier, in both directions.

Other sugars tested (mannose, galactose, xylose and sorbose) passed, like glucose, rapidly across the placenta in both directions. Thus fructose holds a unique position.

This way up

THE orientation of a seed in the soil can affect its development. It was shown 30 years ago that oat seeds in wet sand will absorb water only if their points lie downwards. Similar experiments with conifer seeds have been carried out by W. Zentsch, of Tharandt.

They show convincingly that germination is definitely promoted if the point of the seed lies upwards and the thicker part rests in the sand. Striking results were obtained with spruces (*Picea abies*) where 79 per cent. of the seeds in right position germinated while none at all germinated when stuck into the sand the other way round. For larches (*Larix decidua*) the figures were 42 and 18 per cent. respectively; for pines the difference was smaller but the "right" position was still clearly favoured. (*Naturwissenschaften*, 3/1960, p. 70.)

Soviet base to be moved

THE Soviet Union has now announced its plans for its sixth Antarctic Expedition, that is for the 1960-61 season. It contains no mention whatever of the projected 4,000-mile trek across the interior that was to link the Geographic, Geomagnetic and Inaccessibility Poles by seismic traverse and of which this season's visit by a Russian tractor train

to the South Pole appeared the curtain raiser.

There are, however, plans for setting up temporary stations in the interior of Eastern Antarctica as bases for scientific exploration. Lazarev, the Atlantic coast station established in 1959, is to be built up into a major and permanent base comparable with the Russian base of Mirny in the Pacific sector. The situation of Lazarev is to be transferred sixty to ninety miles inland from the coast to the foot of the Volad mountain range.

Revised time-scale

THE geological time-scale of Holmes, based on the rate of decay of uranium to lead, has been used for many years. In 1959, however, K. I. Mayne proposed to lengthen the scale considerably. New data on the ages of Palaeozoic rocks have been obtained which support the suggestion that the Holmes scale should be extended, though they do not bear out the drastic revision proposed by Mayne. The dates were obtained by two teams working independently and using different methods: one at Lamont, Columbia University, headed by J. L. Kulp; the other at Oxford under A. Mills and at Harwell under R. K. Webster (*Nature*, Vol. 185, p. 495).

At Lamont, isotope dilution techniques were used to determine the rate of decay of radioactive potassium to argon; the Oxford and Harwell measurements were based on the rate of decay of radioactive rubidium to strontium. When the results obtained by the two methods agree, as they did very closely in this case, the age of the sample is almost certainly a true one.

The samples were micas from two sets of granite intrusions from the British Isles. One set, associated with the Caledonian earth movements of Silurian-Devonian times, consists of granites from Shap (Yorkshire), Creetown (Kirkcudbright) and Leinster (Ireland). The other comprises granites from Dartmoor and Land's End, connected with the Hercynian movements of Carboniferous-Permian times. The average ages, in millions of years, are as follows:

CALEDONIAN (Holmes 313)

	Kulp et al.	Mayne
Shap ..	391 ± 7	475-510
Creetown ..	386 ± 8	470
Leinster ..	386 ± 6	—

HERCYNIAN (Holmes 203)

	Kulp et al.	Mayne
Dartmoor ..	271 ± 5	305
Land's End ..	250 ± 15	340

TRENDS AND DISCOVERIES *continued*

Grafts and antibodies

TRANSPLANTING tissues and organs from one person to another to make good the effects of injury or disease has long been a pipe dream of surgeons. It is not want of surgical technique, but what is known as the homograft reaction that is the stumbling block. A homograft is a graft from a donor to a recipient of the same species. Such grafts do not "take" permanently, because the host forms antibodies to the cells of the graft and destroys it.

One of the aims of modern surgery is to overcome the homograft reaction. This can be done to a limited extent by very heavy X-irradiation, but as this causes destruction of the blood cells a search has been made for drugs that might break through the homograft barrier. A promising lead has been found in 6-mercaptopurine, a compound used in the treatment of leukemia. K. Calne, of London, has used this drug to modify the kidney homograft reaction in dogs (*Lancet*, Vol. 1, 1960, p. 417).

He found that if a dog with only one kidney were first primed with 6-mercaptopurine it accepted a kidney graft from another dog. Although dogs so treated subsequently died from pneumonia, careful examination of the grafted kidney showed no signs of the homograft reaction. Dr. Calne thinks that the use of 6-mercaptopurine might offer an approach to transplanting human kidneys, particularly in patients with severe kidney damage in whom the homograft reaction is already depressed.

Surviving marrow

ALTHOUGH the normal result of a graft of tissue from one human to another is rejection within three weeks, the situation is rather different after damage to the antibody-producing system by radiation. In this case the graft produces antibodies against the host which leads to severe illness or death in about six weeks. Dr. J. O. W. Beilby and others, of London, have now reported a case in which a graft of bone-marrow survived for nine months, in the meantime producing cells with the blood-group of the donor which differed from those of the host.

A patient with Hodgkin's disease had been treated with X-rays and anti-cancer drugs which eventually stopped her bone-marrow from functioning, leading to a severe drop in her red and white blood cells. Eventually she was given an injection of bone-marrow cells taken from her sister who had a similar but not identical blood group. Within hours the patient felt better and within four months her blood count was within

normal limits. This was maintained for nine months.

As the cells of the patient's sister contained antigens which the patient lacked, it was possible to follow the proportion of donor cells in the patient's blood. After seven months 24 per cent. were from the donated marrow and after ten months there were 40 per cent. donated cells. This indicates that the donated marrow was thriving and producing red cells along with the surviving bone-marrow of the patient. This situation is known as a blood-group chimera and has been found in non-identical twins. Skin-grafts between donor and patient did not take. The authors conclude that success may have been due to the fact that the donor possessed all the blood-group antigens found in the patient.

The site of antibodies

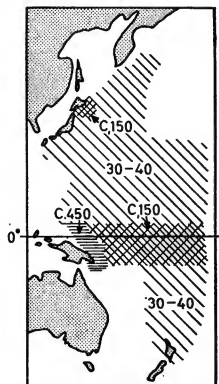
RIBONUCLEOPROTEINS (RNP), complexes of nucleic acids and proteins, are known to be involved in the synthesis of proteins in living cells. Nucleic acids are also thought to play a role in the production of antibodies. Indeed, on elegant preliminary proof that the production of antibodies is associated with the RNP of the antibody-forming organs—the lymph nodes and the spleen—has been described in *Nature*, Vol. 185, p. 317, by M. Feldman and others, of Rehovoth.

Using chemical methods RNP was isolated from lymph nodes and spleens of normal and immunized rabbits. The latter were immunized either with sheep red cells or with horse serum globulin. The isolated RNP was tested for the presence of antibodies by means of a red cell agglutination test.

Neither the RNP from immunized animals nor that from normal rabbits agglutinated the antigenic or antigen-coated red cells. When, however, the ribonucleic acid moiety of the RNP was destroyed by a specific enzyme (ribonuclease) and only the soluble protein part of the degraded RNP was tested, an agglutination was observed between the sheep red cells and the protein derived from the *immune* RNP. No such reaction occurred with the protein derived from RNP from lymph nodes of normal rabbits.

These experiments indicate that the protein moiety of RNP removed from immunized animals contains the antibody; this antibody is not detectable as long as it is bound to its ribonucleic acid, but it may be released upon the destruction of the nucleic acid and participate in an immune reaction with its specific antigen.

Remains on the Pacific floor



DURING the 1957-58 expedition of the Soviet research ship *Vityaz* in the Western part of the Pacific many samples were collected from the bottom of the ocean by dredge and trawl.

The analysis of 42 dredge samples (depths 310-6,135 metres) and 16 trawl samples (2,870-10,710 metres) showed cephalopod remains, in the top layer of the sea-bed, distributed as indicated on the map above as finds per square metre.

No definite relation between the abundance of the remains and depth could be determined. Most of them were in a good state of preservation, some were decomposing, but none showed the iron-manganese deposits found on pebbles and shark's teeth. Therefore the finds are assumed to indicate the profusion or otherwise of the cephalopods in the indicated regions, although currents may have played some part in their accumulation. The profusion near the New Guinea coast may be connected with migrations for breeding purposes.

Sharks' teeth were another usual component of the bottom precipitate; some of them were white and obviously recent, but many were covered with deposit, sometimes up to 5-6 mm. thick. The greatest number, 20-680 to the square metre, were found north-east of the Marshall Islands.

BOOKS

Jet propulsion engines

by T. R. F. NONWEILER

JET PROPULSION ENGINES. HIGH SPEED AERODYNAMICS AND JET PROPULSION. Vol. XII. Edited by O. E. Lancaster. (Princeton University Press: Oxford University Press, 799 pp., 140s.)

How can a reviewer have the temerity to sit in judgment of a book like this? When eighteen experts, all good men and true, unite to produce eight hundred pages of text; when their effusion must be viewed within the context of eleven other volumes of comparable bulk; what can be said in criticism that is not mere carping? Princeton's Aeronautics publication programme was formally established ten years ago, and this volume, though numerically designated the last of the series, comes along after just half of the planned volumes have been published. There have already established a reputation for the series, to which it may be said without disrespect that the present volume can add but little.

That it might detract from that reputation could have been a very real peril, for it discusses the problems that arise from bringing together the various components to form a complete engine, and this of all the subjects essayed in the series must be the most difficult to present tidily and logically. A discussion of compressors and turbines, or of combustion processes, of intakes and nozzles, or of propellers, can each by itself be developed in a straightforward fashion, so that the reader might imagine he completely understands the working of (say) a turbo-prop engine; but to seek the reason why, when combined, they behave as they do, is to invite disillusionment. To overcome these difficulties, only to fall foul of the intricacies of installation and operation of engines, is to learn the true distinction between applied science and practical engineering.

In communicating such engineering "know-how" this book does well enough in its own way; though, to echo the words of R. L. Stevenson, it is a mighty bloodless substitute for life. That the authors have any sort of success at all is an accomplishment, for they are inhibited on the one hand from building up the fundamentals of propulsion, and, on the other, from following up the more advanced aspects of component design, by virtue of the treatment of

these matters in other volumes in the series (some still awaited).

The lengthiest of the various sections concern the gas-turbine (for obvious reasons), the ramjet (conceptually the simplest and the most rewarding to discuss), and, rather strangely, the solid propellant rocket. But all types of jet engine come within its purview, and the least familiar—like the ramrocket, a rocket engine within an air duct—fare best, perhaps because their most troublesome idiosyncrasies have yet to be revealed. The short section on the applications of nuclear energy is particularly notable, and contains a lot more of substance than one is accustomed to find in articles under the same heading—at least in aeronautical books.

But what a lot of jet engines there are

that nobody knows about. One of the contributors constructs a "morphological box" wherein are contained no fewer than 25,344 types of engine, each recognizably different, and the great majority of them still awaiting a Frank Whittle for protagonist; and this classification, he admits, is over-simplified.

In such light, the proportions of the book may seem to shrink. But literally and figuratively it is still too heavy. It has the sequence of a textbook, yet (with its companion volumes) the scope of an encyclopaedia. One may taste its undoubted virtues, yet be discouraged from sinking one's teeth. One is reminded of Dr. Johnson's remark: "Books that you may carry to the fire, and hold readily in your hand, are the most useful after all."

Thresholds of life

THE RITES OF PASSAGE. By Arnold van Gennep. Trans. by M. B. Viazodan and G. L. Caffee. (Routledge and Kegan Paul, 198 pp., 23s.)

"EXCEPT in the few countries where a passport is still in use, a person in these days may pass freely from one civilized region to another" (p. 15). Such a sentence gives one sudden pause. When a book, in addition to containing this gem, rests on sources published prior to 1908, it is legitimate to ask "Why translate, and republish it, now?" The answer is neither comforting nor complimentary to the study of comparative religion. Despite the way in which much of the material is dated, the argument and point of view are as significant as they were when first published fifty-two years ago.

Half a century has seen relatively little progress in the objective study of religion. If anything, it may be more difficult at the present time for the scholar to free himself of his own religious convictions than it was in the closing years of the last century. Also, rationalism and humanism, although both may be espoused in the name of tolerance, have created a climate of opinion which is not conducive to the understanding of religious phenomena. Insistence on the very techniques of the physical sciences may inhibit recognition of regularities in certain other realms of existence.

The *rites de passage* (the phrase is more usual without translation), in which van Gennep recognized regularly recurring ritual features, mark the transition from one stage of life to the other, and occur among all peoples. Emphasis on such occasions as birth and death have often led present-day anthropologists to speak of these as life-crisis situations. Van Gennep avoids such drama, but insists that persons move through the stages of life much as they would pass through doors from one room to another. Rites mark many of the thresholds so that they and their companions become aware of the transitions. He implies that such ritual reorientation is necessary to the well-being of the individual and to the smooth functioning of the group.

Appearance of the book at this time is due to Professor Solon Kimball, who suggests in an Introduction that the approach is relevant to current problems in modern society. This suggestion might profitably be expanded. Is it true, for instance, that cultures with initiation rites, however barbaric they may seem at first glance, cushion the transition from childhood into adolescence so that they are without our problems of juvenile delinquency?

MARIAN W. SMITH

IMPORTANT

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ABELLA

BOOKS continued

Shrubs, trees, ferns and mosses

GARDEN SHRUBS AND TREES. By S. G.
Harrison.

BRITISH FERNS AND MOSSES. By P. G.
Taylor.
(Eyre & Spottiswoode, 318 pp., 226 pp.,
25s. each.)

THE publication of these two volumes
extends the coverage of the Kew Series
considerably. S. G. Harrison's *Garden
Shrubs and Trees*, although complete in
itself, is to a high degree complementary
to R. D. Meikle's *British Trees and
Shrubs*, number two in the series. Al-
though presenting only a selection, made
on the basis of availability and horticultu-
ral merit, it deals with many more
plants than the earlier volume; about 800
including varieties. Of necessity, indi-
vidual accounts are shorter and a higher
proportion of the plants described are
without illustrations. But the author does
a great deal with the space at his dis-
posal. We are provided with the means
of identification, interesting historical
information, and sufficient notes on cul-
tivation to prevent the worst blunders.
This is a book mainly for the amateur
gardener who wants to be better in-
formed on this part of his subject; it is
a book to browse through and to use for
reference.

Peter Taylor's *British Ferns and
Mosses* combines a comprehensive ac-
count of British vascular cryptogams
with an introductory account of British
mosses. The descriptions of the ferns,
clubmosses, horsetails, etc., are excellent
and are supported by information on
both ecological and geographical distri-
bution. All species described are clearly
illustrated, either in colour or black and
white. This part of the book forms a
valuable addition to the literature which
will be appreciated by both botany
student and amateur naturalist alike.
The forty-page section on mosses is less
satisfactory.

Only some fifty-two of the six hundred
British species are described and illus-
trated; and this without reference to micro-
scopic characters. The bryologist can cer-
tainly recognize and name many of his
plants without the aid of a microscope,
but he can only do this because, either
he has been taught to do so by one more
experienced than himself, or he has
spent many hours with his microscope
and genuine moss flora. One is forced to
wonder how many of Mr. Taylor's
readers will thank him for encouraging
them "... to learn more about these
smaller, less conspicuous, but equally
fascinating plants", and how many will
simply object to paying for a part of the
book which they could well do without.

In order that the descriptions given in
these books should be both accurate and
reasonably brief a considerable number
of technical terms are used. To help
the novice these terms are explained
in short introductory sections, and brief
definitions are given in glossaries.
Although the introductory sections do
contain much of value they appear to
have been written as much to puzzle as
to enlighten, and they will surely confirm
the reader's worst fears about botany and
the mentality of botanists. Many of the
terms introduced are quite unnecessary,
some of them appearing again only in
the glossaries. Some of the ideas ex-
pressed are surprisingly naive for such
authoritative works and a few are defi-
nitely archaic. But these books deserve
extended lives and some of these minor
points may receive attention before
future editions appear.

R. E. PARKER.

A history of science

THE ROAD TO MODERN SCIENCE. By H. A.
Reason. (G. Bell & Sons Ltd., 344 pp.,
20s.)

THIS is a third edition of a very popular
book that first appeared nearly twenty-
five years ago. It has been thoroughly
revised, however, and brought up to
date. If one ignores some historically
doubtful statements in the earlier pages
the rest of this book is decidedly good.

It is evident from the style that it has
been written for the adolescent reader.
Perhaps it is a pity, though, that the
author should have worked into the text,
parenthetically as it were, the meanings
of half-technical words that might just
as easily have been left out altogether.
There is a wide difference between the
kind of simplicity that would recommend
a history of science to any reader, and
otiose explanations that belong more
properly to the dictionary. Mr. Reason
has treated his subject as a series of
sketches of how the main topics of
science have developed.

Preferring to deal with one thing at a
time, he traces the main themes of
physics, astronomy, chemistry, biology,
etc., from earlier periods to our own day,
and it cannot be denied that this piece-
meal approach is most successful here.
The best chapters of the book are prob-
ably those on chemistry and biology,
where the researches and reasonings that
led to the overthrow of the phlogiston
theory in one science, and to the estab-
lishment of the theory of evolution in
another, have been written up as most
intriguing account.

EDWARD BEST.

BOOKS *continued*

Theory of interference and diffraction

PRINCIPLES OF OPTICS. By M. Born and E. Wolf. (Pergamon Press, 803 pp., 120s.)

THE everyday pressure on modern physicists, even more than the rapid advance of their subject, inhibits the writing of textbooks equal in distinction to the classics of the nineteenth century. We can no longer hope for books such as the *Treatise on Electricity and Magnetism*, by Clerk Maxwell, and the *Treatise on Natural Philosophy*, by Thomson and Tait, had they lived today, Maxwell and Kelvin would have been overwhelmed with duties that denied them the leisure to write their celebrated books.

Another such book was Drude's *Theory of Optics*. Written shortly before the formulation of relativity and quantum theory, it was a vintage text; and despite all the books on optics in the intervening sixty years, there are still some useful things to be found more easily in Drude than in most of the more recent treatments.

The news, some years ago, that Professor Born was preparing a new book on the *Principles of Optics*, in collaboration with Dr. Wolf, aroused some of us to the hope that, with the deep physical insight of the authors, a book would at last appear that would do for modern optics what Drude's book did for the optics of the nineteenth century. The time required for preparation, the size of the volume, and its price, all confirmed us in this hope; but now that the book has appeared, it is clear that it is not comprehensive in the way that Drude was. In fact, it has a sub-title, "The electromagnetic theory of propagation, interference and diffraction of light", and this is a much fairer statement of what the book sets out to do. Even so, it is surprising to find no treatment at all of radiation pressure or of the angular momentum of light; these phenomena, which link optics with mechanics, ought surely to find a place in any book claiming to deal with principles. Moreover, there is only one trivial reference to a black body in the entire 800 pages of the book, and there is no hint of those links between optics and thermodynamics which lead to such interesting results as the radiation from a black body being proportional to the square of the refractive index of the medium into which it is radiating. The uncertainty principle, which has some of its neatest examples in optics, is hardly mentioned. There is only one entry under "photons" in the index, and this is given to a page on which the indexed word does not appear.

To continue a list of negative criticisms would be ungrateful to the authors; my purpose in giving the foregoing examples has been to make it clear to readers of this review that the title of the book is misleading. Disappointment is all the sharper because we know how admirably Professor Born could have dealt with the wider principles of optics had he so chosen. I should have warmly exchanged the chapter on the diffraction of light by ultrasonic waves, which is hardly a principle of optics, for even a summary of Professor Born's comments on the subjects mentioned in the preceding paragraph.

On the positive side, the book gives the most comprehensive treatment, in English at least, which has yet appeared on the theory of interference and diffraction, including a rigorous theory of diffraction at a straight edge (although, curiously, it does not mention the phenomenon of polarization of light by slits). Both the geometrical and diffraction theories of aberrations are treated thoroughly, and there is a particularly good discussion of the phenomenon of phase change around a focus. Otherwise, there is some uneven-

ness of treatment, especially when the subject verges on experiment. There is no reference to measurements of the velocity of light, for example, after 1941; and the treatment of the diffraction grating, though good as far as it goes, could with profit have been taken farther. The difficult subject of partially coherent light is well treated; this is one of the fields in which Dr. Wolf has worked with much distinction. In fact, it might not be unfair to describe the volume as based on Professor Born's *Optik* of 1933, and substantially expanded in those branches of optics in which Dr. Wolf has himself worked. The result is nearer a monograph than a balanced book, but this will be of much value to other workers whose interests coincide with those of Dr. Wolf, and to other readers who wish to take advantage of his specialist knowledge.

In summary, the book does not fulfil its title, and is therefore hardly a justifiable purchase for the reader hoping for an outstanding compendium of optical principles. It will, however, have great value as a reference book on interference and diffraction theory; and, as such, all physics libraries will need it.

R. V. JONES.

Pest ecology

CONSEQUENCES OF DISTURBANCE. The Pest Situation Examined. By Alan Mozley. (H. K. Lewis & Co., 61 pp., 9s.)

THE object of this little book is to stress that the principal reasons for outbreaks of any pest organisms are disturbances of stable natural ecological systems and the creation of new habitats by irrigation, ploughing, grazing, etc. As stated in conclusion: "Healthy points of view are: Do not devote a disproportionate amount of time to killing a pest organism. Limit its scope and range. Think of tomorrow's crop of pests." The author admits that this approach is not a new one, but it certainly needs to be popularized.

Unfortunately, the manner of its presentation merely obscures the main issues, since the book appears to be a loosely arranged series of hurried notes, unsupported statements and philosophical deviations. A lay reader is likely to be confused by casually mentioned examples of various organisms, the role of which in relation to Man the author often does not bother to explain. Biologists will, probably, dismiss the book for being too sketchy, which would be regrettable, as scattered through it are some bold criticisms and suggestions which might have attracted attention if they were better formulated and more convincingly presented.

B. P. UVAROV.

Other books received

ATMOSPHERIC BENZENE. By A. G. Thomas. (Hutchinson & Co., 21s.)
PRINCIPLES OF RADIOISOTOPE METHODOLOGY. By Graef D. Chase. (Mayflower Publishing Co. Ltd., 48s.)
BIOGRAPHY AND ECOLOGY IN AUSTRALIA. Edited by A. Kest, R. L. Crocker, C. S. Christian. (Dr. W. Junk, 65 Dutch Guilders.)
LET'S EXPLORE CHEMISTRY. By Nathan Feiler. (Sentinel Books: Mark Paterson & Co., 8s. 6d.)
SUNSET IS EXCITING. (Blackie & Son Ltd., 7s. 6d.)
ELECTRONIC COMPUTERS — PRINCIPLES AND APPLICATIONS. By T. E. Ivall. (Hilff & Sons Ltd., 25s.)

THE MANY BODY PROBLEM. Lectures given at the Summer School, 1958. University of Groningen, School of Theoretical Physics. (Methuen & Co. Ltd., 108s.)
MONOGRAPHIAE BIOLOGICAE. V. No. 2. On ageing and old age. By M. D. Drmek. (Dr. W. Junk, 14 Dutch Guilders.)
THE DIRECTORY OF OPPORTUNITIES FOR QUALIFIED MEN 1950. (Cornmarket Press Ltd., 8s. 6d.)
PHYSIOLOGY OF THE RETINA AND VISUAL PATHWAY. By G. S. Brindley. (Edward Arnold Ltd., 35s.)
RESIDENCE AND TECHNICAL EDUCATION. Report prepared by Dorothy Silbertson. (Max Parrish, 16s.)

CONTRIBUTORS

SIR ALISTER (CLAVERING) HARDY (*Was Man more aquatic in the past?*), a Fellow of Merton College, Oxford, is Linacre Professor of Zoology and Comparative Anatomy in the University of Oxford. He was born at Nottingham in 1896, went to Oundle School and became an undergraduate at Exeter College, Oxford. In 1920 he was Christopher Welch Biological Research Scholar as well as Oxford Biological Scholar at the Stazione Zoologica in Naples. The following year he became an assistant naturalist in the Fisheries Department of the Ministry of Agriculture and Fisheries.

From 1924 to 1928 Sir Alister was chief zoologist to the *Discovery* expedition. Then he settled down at the University College of Hull, where he held the Chair of Zoology and Oceanography for fourteen years. He later moved to the University of Aberdeen as Regius Professor of Natural History, then took up his present post. He won the Scientific Medal of the Zoological Society in 1939, was elected a Fellow of the Royal Society in 1940 and received his knighthood in 1957. He has been joint editor of *Bulletins of Marine Ecology* and has published a number of books on the biology of the sea, including *The Open Sea*, in two parts—*The World of Plankton* and *Fish and Fisheries*. Sir Alister is married, with two children. His recreation, water-colour sketching, has also provided delightful illustrations to his books. (pages 642-645)



JOHN WEST (*Research for the Canberra*), who designed the new liner, was born at Hebburn-on-Tyne, Durham, in 1927. He was educated at Jarrow Grammar School, Rutherford College of Technology and King's College, Durham University. Besides final certificates in practical shipbuilding and naval architecture which he obtained at the City and Guilds of London Institute at the age of eighteen, Mr. West holds an honours degree (BSc) in naval architecture. After his early training at the shipyard of Hawthorn, Leslie & Co., he studied shipbuilding in France as a foreign exchange student. In 1952 he joined the P & O company as assistant naval architect, and in 1956 he was promoted to assistant to the management and technical adviser. He worked, among other things, on recent additions to the company's cargo fleet, and developed the early designs for tankers—a new departure for the group. Mr. West lives at Epsom, is married and has one child. (pages 646-648)



WILLIAM JOHN BRAY (*Possible uses of microwaves in telecommunication*) entered the Post Office Engineering Department in 1934, and since 1958 has been staff engineer in charge of its Inland Radio Planning and Pro-

vision Branch. The branch is concerned with broadcasting, radio interference and the planning and provision of microwave links and mobile radio services. Mr. Bray is International Chairman of Study Group IX (Radio-relay Systems) of the International Radio Consultative Committee (CCIR). He holds an MSc degree in engineering and is a member of the Institution of Electrical Engineers. (pages 649-652)



GARTH HOOD CHRISTIAN (*The future of commons*) is the author of *A Place for Animals* and a free-lance journalist. Since 1950 he has been editing *The Plough*. From 1954 to 1956 he was also editor of the *Sussex County Review*. Mr. Christian is Nature Conservator for Chailley Common, Sussex. His special interests include the study of wild birds and mammals in their natural haunts and the influence of toxic sprays on wild life. One of his hobbies is the taming of wild birds: in winter flocks of up to 100 great, blue, marsh and coal tits commonly come to the hands of visitors to his cottage. (pages 661-664)



GEORGE BRIAN THOMPSON (*The shape of gear teeth*) has been a research physicist on the staff of Associated Electrical Industries at Rugby since 1953. In that capacity he is engaged on theoretical gear research. Problems in the design and manufacture of gears interest him especially. Mr. Thompson, who is 30, trained at Hatfield College, Durham, where he obtained a BSc degree in 1953. He is married. Swimming is his favourite sport: he was captain of his college swimming club. (pages 665-667)



TERENCE R. F. NONWEILER (*Jet propulsion engines*) is senior lecturer in the Department of Aeronautical Engineering at Queen's University, Belfast, having joined the Department soon after it was formed in 1957. In addition he acts as a consultant to Government departments and the aircraft industry. Mr. Nonweiler, who was born in London in 1925, is a graduate—in mathematics—of Manchester University. Between 1944, when he graduated, and 1951 he was a scientific officer at the Royal Aircraft Establishment, Farnborough, concerned with theoretical aerodynamics and project assessment, mostly relative to high-speed flight, jet propulsion and rockets. Subsequently he lectured in theoretical aerodynamics at the College of Aeronautics, Cranfield, for several years. Mr. Nonweiler's professional interests range from submarines to man-powered flight. His hobbies include acting and verse-speaking. He is married and has four sons. (page 673)

LETTERS

Supersonic engines

Sir,—I was very surprised to see, under the heading of "Joint effort in super-sonics" (*Notes and Comments*, 25 February), the statement that "Mach 3 (roughly 2,000 mph at height) will put out of court the ramjets which were once being considered."

If you would turn to Dr. R. R. Jamison's article, *The supersonic airliner and its power plant*, in your issue of 17 September, 1959, you will find that Mach 3 is considered the ideal speed for ramjet engines!

D. H. WHALEY.

Bristol Siddeley Engines Limited,
Filton, Bristol.

Our contributor writes:

Mach 3 is not so much the ideal speed for ramjets as the speed at which they begin to offer an advantage in fuel consumption. Theoretically, they should be still better at higher speeds; but there are heating troubles in engines as well as in airframes at the higher speeds and the relatively small amount of experience accumulated in the operation of expendable ramjets at lower speeds is now thought to make the solution of such difficulties in them a bigger task than will arise if developed gas turbines, designed for supersonic speeds, are used.

Funeral rites of a Viking

Sir,—While studying the way of life of the Vikings in the hope of shedding light on an archaeological discovery in Ilford, Essex, I was reminded of a note which appeared in *The New Scientist* (29 January, 1959, p. 218). This concerned the method of preservation of meat investigated by scientists of the Battelle Institute in Geneva and consisting of an injection of adrenalin which, it was explained, caused muscle to become devoid of carbohydrate and unable to assume the acidic condition which precedes enzymatic decomposition.

An Arabian diplomatic courier, who witnessed the funeral of a Viking chieftain on the Volga in the year AD 922, related that the finely dressed body was laid in a ship which was prepared for the voyage to "Paradise". After various possessions and foodstuffs had been put on board, two horses were led up, run about until they were in a sweat, and then chopped into pieces which were thrown into the ship. Accompanied by the body of a young woman who had volunteered to travel with him, the chieftain was dispatched by the burning of the entire structure.

Though the origin of the practice of thus sacrificing animals is apparently lost, it is not possible that such a treatment caused a local carbohydrate deficiency similar to that induced by an injection of adrenalin and thus retarded the putrefaction of the meat? The nature of the life of many Vikings must have provided them with numerous corpses (animal and human), some killed after a chase, some more peacefully succumbed, and casual observations possibly correlated fatigue at the time of death with preservation of the body.

SIDNEY C. ALFORD.

The Science Department,
SW Essex Technical College,
Walthamstow, E17.

Engineering and technology in the 1960s

Sir,—Professor M. W. Thring (*Letters*, 25 February) looks forward to the development in the next ten years of an economic heating appliance using small coal, and with no handling of fuel or ash, controllable and smokeless.

For many years, I have successfully used such appliances in my own home, safely and economically. The small coal is burnt remote from the appliance, handling of fuel and ash is mechanized and the heat output can be thermostatically controlled.

The appliance is known as an electric fire.

R. M. LANG.

Bourne Close,
Winterbourne, Bristol.

Language and the brain

Sir,—The value of any type of model in science can only be upheld subject to certain very stringent limiting conditions, and it seems to be particularly dangerous to introduce mechanical models as "indicating the nature of the task which the brain . . . must perform". (See the article by Professor Meredith, *Language and the brain*, 25 February.) While such models may have value in suggesting analogies and further experiments, the function of Professor Meredith's "Chromatropes" is rather to cloud than to clarify the issue—if, indeed, they are relevant to it at all.

Moreover, on his own ground, there seems to be little basis for his distinction between the "inner" mechanism of understanding and an "explanation in terms of behaviour". His description is, in fact, of an inner behavioural

mechanism and, as such, has little additional explanation-value.

DAVID PATERSON.

St. Edmund's House,
Cambridge.

Professor Patrick Meredith replies:

"Dangerous to introduce mechanical models"—agreed. Words are also dangerous and so is science. Surgery is particularly dangerous. Exploration is not for the timid.

"Rather to cloud than to clarify the issue"—what issue has Father Paterson in mind?

"Inner behavioural mechanism"—I described a visible, workable mechanism which will do a certain simple job when fed with coded radiation. The brain is a physical system which also does this job, and many more complex jobs. These jobs have been described in many conflicting terminologies, leaving many cloudy issues. By treating language as a form of modulated radiation (which physically it is), and constructing models which work by radiation and perform similar tasks, I hope to remove some of the clouds. Father Paterson is entitled to his doubts and I thank him for his comments.

Psycho-analysis

Sir,—Geminis (25 February) is wrong in suggesting that no sufficiently comparable samples exist to support the belief that psycho-analysis is no more effective in treating neuroses than is the patient's own spontaneous remission.

An American study of 500 disability claims submitted to the Equitable Assurance Company by neurotics is particularly worthy of consideration. These patients were in the same socio-economic class as the majority of people who receive analytic treatment, and, since their number was also large, they would be expected to provide a fairly reasonable control group. They had all been ill of a neurosis for at least three months before submitting claims, and had been unable to continue in their occupations for that time, so that they could in fact be regarded as "severe" cases. Treatment was in the hands of their own physicians and took the form of sedatives, tonics, suggestion and re-assurance, and no psychotherapy of any kind was given. Careful investigation by the company, as well as by repeated reports from physicians, showed that no productive work was done by the patients during this time. The fact that disability benefits were regularly paid may have actually inhibited recovery, or, as the author of the original article writes: "One would not expect the therapeutic results in such a group of cases to be as favourable as in other

LETTERS *continued*

groups where the economic factor might act as an important spur in helping the sick patient adjust to his neurotic conflict and illness."

A follow-up study lasting for more than five years used the following criteria of recovery: (1) Return to work and to continue good economic adjustments for at least five years; (2) no further or only slight difficulties; and (3) making successful social adjustments. On these unequivocal criteria, 72 per cent. of the patients recovered after two years and 90 per cent. after five years. In the two-year period, the recovery rate is two out of three patients, which is the same as that generally put forward for neurotics treated by psycho-analysis.

It would be extremely difficult—if not impossible—to furnish a truly stringently matched control group for proper conclusions to be drawn, but this should not mean that we must rigidly dismiss findings which are suggestive when acceptable "approximate" controls are used, as in the above case.

ROBERT COOPER.

London Road,
Reading, Berkshire.

The scientist and science fiction

Sir.—Fortunately Geminus wrote about science fiction in an issue (18 February) which also contained a factual contribution by John Lear and a first-class analysis of SF in a letter by John T. Philpitt.

Even so, he really ought not to be allowed to get away with it: his complete inversion of the facts just will not do.

One of the most important attributes which the adult reader of science fiction seems to share with too few others these days is the possession of an *open mind*—the kind of thinking which enabled the gentleman amateurs of the past to make fundamental discoveries and which still distinguishes the truly experimental scientists from today's mass of scientific civil servants. It is therefore far easier to imagine a professional scientist "falling for these things" (i.e., reading prophecy into SF when it isn't there) than the most recent of SF aficionados.

It does seem curious, however, that "the erstwhile down-to-earthers in the Soviet Union" now indulge in a little original speculation. Only a little while ago we were told that the climate of thought in Soviet Russia would preclude that sort of thing—but perhaps this is a reaction. Just let it be remembered that the "Space Travel is Bilge" school laughed at the very thought of artificial satellites very, very few years ago: why should we not at least consider with a straight face the speculations of the

scientists who had the last laugh in this matter?

John Lear reports fairly and open-mindedly on work being done to puzzle out whether our Moon is dead or not. Is it "insidious and potentially misleading" to inquire into such things just because imaginative writers have long ago refused to accept the (apparently ephemeral) scientific notion that the Moon is dead? Are scientific inquiry and speculation only to be confined to what is known?

By a very odd coincidence, John W. Campbell, Jr. (Ph.D.), has devoted his editorial in the March issue of *Astounding Science Fiction* (British edition) to a speculative discussion of "the ultrafeeble interactions", advancing the theory that rocket power will not achieve space travel, but that the feeble but cumulative forces of gravity will have to be studied and overcome. Part of his argument is that in order to study such forces—much eclipsed in sheer power by potent forces such as electromagnetic influences—

centrifugal gadgets, torsion balances, etc., would have to be made of lead, or, "... better still, *silica masses* ...". Well, to the open-minded here is one reason why the supposed space-ship that gave rise to the occurrence of tekites should be "mainly made of silica", to quote Geminus!

No, SF is not meant to be prophecy: but with so much speculation going on some of its guesses are bound to come near the truth, such as nuclear-powered appliances which were "foreseen" in SF many years before Hiroshima. Geminus should remember that however many "credulous people" may become convinced that whole worlds of fantasy will become reality, it will not include the regular readers of science fiction. And the best remedy for all concerned will be to join us and develop the open mind so desperately needed these days.

IAN S. MENZIES.

Longmarsh View,
Sutton-at-Hone, Kent.

Dust measurement

Sir.—There is one method of dust sizing which was not mentioned in Mr. J. R. Hodgkinson's article *Measurement of airborne dust in mines* (11 February). This method has the advantage of being very rapid and accurate. It is a non-optical method, giving direct measurement of particle volume, unlike any other system, in the range 1-200 microns.

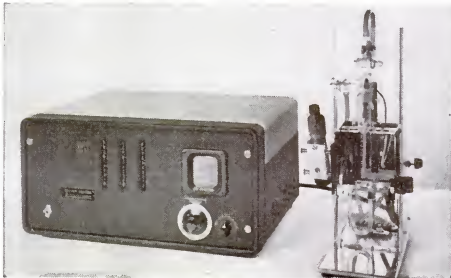
The "Coulter Principle" involves drawing a suspension of dust in a suitable electrolyte (e.g. 0.9 per cent. saline) through a small orifice. Electrodes are placed at either side of this orifice and an electric current passed through. Changes in current, due to the

passage of a particle through the orifice, produces short pulses whose amplitudes are proportional to particle volume.

A threshold, above which amplitude pulses will be counted, can be varied in steps to provide a size distribution analysis. Complete analysis can be performed on any sample by unskilled personnel in about ten minutes, but a single count of number of particles above a given size can be made in fifteen seconds. A maximum of 150,000 particles may be counted in this time.

M. I. HENDERSON.

Auriol Mansions,
Edith Road, London, W14.



The "Coulter Counter".

LETTERS *continued*Too many scientists—
or too few?

Sir,—Mr. D. Comino in his letter of 4 February states, briefly:

(1) that he believes that scientific minds in managerial positions will benefit industry and government, but scientists do not attain these positions due to their own unwillingness to offer themselves as trainees for such work.

(2) that arts graduates get ahead, occupy the higher and better paid positions and the scientists find themselves being managed and frustrated by people who do not understand them.

(3) that it is clear that science graduates with the best brains are snapped up by industry for scientific work and firms like his own are faced with the choice between mediocre science graduates and first-class arts graduates as potential managers.

(4) that because 39 out of 67 members of the Soviet Praesidium have had a scientific or technical training, scientific and technical subjects get a higher priority in the USSR.

I comment as follows against each item above:

(1) In his first letter (14 January) on this question he stated that his company had tried training scientists for managerial positions quite unsuccessfully. It would seem logical, therefore, for Mr. Comino to have added in his second letter that it had been possible to persuade some scientists to "offer themselves" for management training but they (the scientists) had found that their fears were verified and that they were indeed not suitable subjects.

(2) How can Mr. Comino say that arts graduates occupy higher managerial posts and yet in the same paragraph infer that they are unable to understand the scientists who work under them? I believe that the most obvious necessary ability of a manager is to understand those under him.

(3) Firstly, in this statement it is inferred that Mr. Comino's firm does not engage in scientific work. I am surprised. Secondly, I am sure it is not possible to classify a mediocre scientist or a first-class arts graduate with respect to their abilities as potential managers. For instance, I fail to see how it is determined that an historian with a first-class honours degree has greater managerial potential than a physicist with second-class honours. I am, of course, sure that Mr. Comino did not intend to generalise but had some specific cases in his mind particular to his company, but this sort of indiscreet comment does high-light the whole text of his letter.

(4) This is the kind of statistical evidence which is advanced so many times in support of an argument. It is a

typically non-scientific approach to any problem and its validity will always be questionable where it is the only fact advanced.

In conclusion my observations, based on my own experience, are that the best administrators and managers are those people who are sufficiently versatile to combine the best attributes of their work group, be they artists or scientists, thus showing an overall understanding of the problem of people as well as those of industry.

My verdict—too few by far!

Bulwer Road, W. A. CRAMP.
New Barnet, Herts.

Causal mechanics

Sir,—In your article, *Causal mechanics*, a Russian scientific controversy (26 November), it is stated that Dr. N. A. Kozyrev claims to have found by experiment that c_2 —the constant he calls "the speed of transformation of cause and effect"—is equal to Kc^2/h where K is a numerical constant equal to about 2, e is the charge on the electron and h is Planck's constant. However, this relationship can be deduced theoretically from a consideration of the hydrogen atom, assuming that Kozyrev's main suggestion—that effect always follows cause by a finite time interval—is correct.

The hydrogen atom will be regarded for the purpose of this calculation as consisting of an electron of charge $-e$, revolving in a circle of radius r , around a nucleus of charge $+e$, and held together by the electrostatic force of attraction between the electron and the nucleus.

At any given instant the electron is acted on by the electrostatic force, but if Kozyrev is correct this force originated at an instant $2r/c_2$ secs. previously. For when the electron is moving at a distance r from the nucleus, the change in direction of the electrostatic force between the nucleus and the electron due to the latter's motion will take r/c_2 secs. before acting on the nucleus and a further r/c_2 secs. before reacting on the electron, assuming that cause does follow effect as Kozyrev suggests. Thus there will be a total time interval of $2r/c_2$ secs. between the appearance of the electron at a particular point in its orbit and the reaction of the electrostatic force at that point. If c_2 is infinite, this force would appear to act instantaneously. But Kozyrev suggests that c_2 is finite, and if this is so $2r/c_2$ is finite, and the electron will have moved away from the particular point by the time the force reacts at that point. The hydrogen atom would thus lose its electron as the force needed to maintain circular motion does not act on the electron but at the point the electron was at a few moments previously.

However, there is one case in which the hydrogen atom will keep its electron; this is when the electron completes its orbit round the nucleus and is back at the particular point again in the time taken between the arrival of the electron at the point and the reaction of the electrostatic force at that point, i.e. if c_2 had such a value that $2r/c_2$ were equal to the time required for one complete orbit of the electron. It can be proved that the time required for one complete orbit is rh^2/c^2 secs.

Thus: $rh^2/c^2 = 2r/c_2$
therefore $c_2 = 2c^2/h$.
M. A. MOORE.
Stainecross Avenue,
Huddersfield.

The qualities needed
for astronomy

Sir,—Although I enjoyed reading the article by Professor R. O. Redman, *Astronomy in the 1960s* (11 February), I was most disturbed to read that, as regards new recruits to astronomy, "the qualities needed are those of first class physicists". I do not dispute this, but what was the reason for Professor Redman omitting the two extra words: "and mathematicians"? It has been an accepted fact for some time now that the two basic sciences one needs to know in astronomy are physics and mathematics, though the former is admittedly the more important. It would also be exceedingly difficult for much progress to be made in computing work unless mathematicians were available. Does Professor Redman dispute this?

Also, why does he state that "the men we need most are born and not made"? The idea that certain types of people are born and not made is a fallacy which I thought to be dead by now. It is most disturbing to see Professor Redman incarnate the idea.

I cannot agree with the implications behind either of the above points, and should therefore be glad if he would explain them in more detail.

GEORFFREY HOLT.

Ferens Hall,
Cottingham, East Yorkshire.

Professor Redman writes:

Any first class physicist has to know a fair amount of mathematics and often he knows a very great deal. I assumed when writing that this would be generally understood. No one can dispute that mathematical techniques are indispensable in physics and astronomy.

On Mr. Holt's second point, I am convinced that if a man is not born with much more than average intelligence, coupled with some degree of originality and a large amount of drive and determination, he will never make a first class scientist, no matter what education he receives. I believe most experienced teachers would agree with me.

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REPLIES to BOX NUMBERS should be addressed to the Box Number given, c/o THE NEW SCIENTIST, Crownhill House, Falmouth, Cornwall, W.C.1. Tel: 01752 7554.

Orders for classified advertisements are accepted subject to the terms and conditions shown on the advertisement rate card, a copy of which will be sent on request.

OFFICIAL APPOINTMENTS

7s. per line—Box Number 1s. extra.

COUNTY BOROUGH OF BOLTON BOLTON TECHNICAL COLLEGE

Applications are invited for the following post, duties to commence September, 1960—

MANAGEMENT STUDIES SECTION

Lecturer, with a degree or equivalent qualification, and knowledge of at least one of the following subjects: operational research, statistical method and theory, information and communication theory, data processing and computer programming. Ideally he will have had industrial research or development experience in these or related matters, and recognise cybernetics as an emerging science particularly related to management.

The Management Studies Section is newly established and offers excellent scope for original work. A three year full-time Cadet School of Management Studies is already established and an Adult Management Training School will open shortly. The section is primarily concerned with education and training for Management as a profession—that is, the activities of decision making, communication and control, and the art of directing human activity. In addition the section will offer courses on specialist subjects in collaboration with other departments of the college. Research will be encouraged.

Candidates should have good industrial and/or educational experience suitable for this position and should hold a recognised qualification in the work to be done. The position is additional to the present establishment consequent on the continued expansion of the work of the College.

Salary will be in accordance with the current Burnham scales for teachers in Technical Colleges, viz.

LECTURER—£1,370 x £35 to £1,550.

Commencing salary will depend on experience and qualifications.

Application forms can be obtained by forwarding a foolscap s.a.e. to the undersigned, to whom completed applications should be returned not later than Friday, 1st April.

Chief Education Officer, Education Office, Nelson Square, Bolton, Lancs.

PATENT EXAMINERS AND PATENT OFFICERS.

Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 29 (16 for Examiners) with extension for regular Forces service and Overseas Civil Service. Qualifications: normally first or second class honours degree in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.M.E., A.M.I.E.E., A.R.I.C. London salary (men) £655-£1,460; provision for starting pay above minimum. Promotion prospects. Write CIVIL SERVICE COMMISSION, 17 North Audley Street, London, W.1, for application form, quoting S.128/60, and stating date of birth.

UNIVERSITY OF HONG KONG CHAIR OF CHEMISTRY

Applications are invited for the Chair of Chemistry which will shortly become vacant owing to the retirement of Professor J. E. Driver.

Annual salary (superannuable) is £3,250 for a man or £2,450 for a woman, together with an expatriation allowance of £350 a year if applicable. The equivalent of income tax in the Colony is comparatively low.

Expatriate staff and their families are provided with furnished accommodation at a reasonable rental, and with first-class sea-passages on first appointment and leaves.

Further particulars and information as to the method of application may be obtained from the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in Hong Kong and London, on 30th MAY, 1960.

UNIVERSITY OF OTTAWA Ottawa, Canada

DEPARTMENT OF MATHEMATICS

Applications are invited from persons with Ph.D. standard for the position of ASSISTANT PROFESSOR in MATHEMATICS. Specialization in Statistics preferred but not essential. Salary, depending on qualifications and experience, with the range \$6,500-\$7,500 p.a. Pension, health and life insurance schemes are in effect. Applications should be sent to the Chairman, Department of Mathematics, not later than April 15, 1960.

UNIVERSITY COLLEGE OF GHANA

Applications are invited for the CHAIR OF ZOOLOGY. Salary £G2,500 p.a. F.S.S.U. Outh and family allowances. Passages for appointee and family on appointment, leave and normal termination. Part-furnished accommodation at a charge not exceeding 7.5% of salary.

Detailed applications (8 copies) naming 3 referees by 20 April 1960 to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

COMMONWEALTH OF AUSTRALIA COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

CHEMICAL RESEARCH LABORATORIES

APPOINTMENT OF CHIEF DIVISION OF PHYSICAL CHEMISTRY

Applications are invited for the position of Chief of the Division of Physical Chemistry in succession to Dr. K. L. Sutherland who is taking up a research position in industry.

The Division of Physical Chemistry is one of the six major units of the Chemical Research Laboratories of C.S.I.R.O., which have their headquarters on a common site in Melbourne. A spacious new site has recently been acquired for the Laboratories adjacent to Monash University, which is now being established at Clayton, Melbourne, Victoria. The Division will be transferred to that site at some future date.

The Division has an annual budget of approximately £A75,000, and has free use of library, central workshops, stores, canteen, clerical and other facilities. It has a professional staff of 25, including 17 in the research classifications, and a total staff of 33. It has close liaison with industry, public utilities, the universities and other parts of C.S.I.R.O.

The work of the Division includes both basic research and applied research, and is centred about problems of importance to the nation or to development of the science of physical chemistry. Among its present projects are (i) the application of surface chemistry to studies of evaporation control in water storages (Mansfield process), to nucleation to form ice as a starter for rain formation, and to separation processes based on absorption; (ii) theoretical and experimental studies of the properties of liquids; (iii) chemical effects of high pressures up to 250,000 atmospheres; (iv) the chemistry of carbon; (v) metal organic complexes and enzymes; (vi) bush-fire research; (vii) desalination studies. The Division's programme has varied considerably over past years and the successful candidate will have ample opportunity to influence future developments.

Applicants should have high academic qualifications and a considerable amount of research experience. Some experience as a scientific administrator is desirable.

The appointment will be conditional upon a satisfactory medical examination and carries with it Commonwealth Superannuation Fund or Commonwealth Provident Account privileges.

The salary offered for the position is £A4,902 p.a.

Further particulars and a copy of the Division's latest annual report may be obtained from the Director, Chemical Research Laboratories. The Director of the Chemical Research Laboratories will be in London during part of April, and available for discussion by appointment.

Applications quoting Appointment No. 586/4, and stating full name, place, date and year of birth, nationality, marital state, present employment, details of qualifications and experience, and of war service if any, together with the names of not more than four persons acquainted with the applicant's academic and professional standing, should reach the undersigned by the 25th April, 1960.

E. J. DRAKE, Chief Scientific Liaison Officer, Australian Scientific Liaison Office,
Africa House, Kingsway, LONDON, W.C.2.

OFFICIAL APPOINTMENTS—contd.

NATIONAL RESEARCH COUNCIL,
CANADADivision of Building Research
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Applications are invited for the following vacancies:

A RESEARCH POSITION IN ENGINEERING SEISMOLOGY, for work on ground vibrations and their effects on building structures. The field of interest may include theoretical or applied work on the seismic design of buildings, the effects of blasting operations on buildings, the design of machine foundations and other problems. Excellent facilities are available for laboratory and field studies including access to digital and analogue computers. Approximately half of the research effort will be in basic research, the remainder in specific engineering problems. Applicants must have an honours Bachelor's degree or higher in Physics, Engineering Physics, Applied Mathematics or similar disciplines and some related training or experience.

A RESEARCH POSITION IN BUILDING ACOUSTICS. The field of interest includes theoretical and experimental studies relating to room acoustics, sound absorption and transmission and industrial noise control. Special laboratory facilities include three reverberation rooms, a free-field room and associated electronic equipment. Digital and analogue computer facilities are available. Approximately half of the research effort will be in basic research, the remainder on supervision of design measurements, design of special buildings and similar specific problems. Applicants must have an honours Bachelor's degree or higher in Physics, Engineering Physics or Applied Mathematics and experience in some aspect of wave propagation.

Salaries will depend on education and experience. Applications and requests for further information should be addressed to:

Employment Officer,
National Research Council,
Ottawa 2, Ontario,
Canada.

UNIVERSITY COLLEGE OF
NORTH STAFFORDSHIRE

Two vacancies exist in Department of Geology for ASSISTANT LECTURERS or LECTURERS. Candidates should have a good Honours degree in Geology. One vacancy requires special interest and research experience in Geochemistry, the other requires design and research experience in Structural Geology. Salary in the scale £700 x 50-£850 (Assistant Lecturer) or £900 x 50-£1,350 x 75-£1,600 p.a. (Lecturer), with F.S.S.U. and children's allowances. Applications should reach the Registrar, The College, Keele, Staffs., from whom application forms and further particulars may be obtained, not later than 23rd April, 1960.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER IN INORGANIC CHEMISTRY in the Faculty of Science. The salary will be on a scale £900 to £1,650 and with membership of the Children's Allowance Scheme and F.S.S.U. Applications should be sent not later than 15th April, 1960, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

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SOUTH SHIELDS
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FOR BOYS

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Required in September, 1960, or earlier:
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The School has modern well equipped laboratories and a strong Science Sixth Form.

For suitable applicants there is the possibility of work up to Open Scholarship standards and a Special Allowance.

Candidates with experience in addition will be considered for the post of Head of the Biology Department (£2,100 allowance).

Forms of application may be obtained from the Head Master, Grammar-Technical School for Boys, St. Mary's Avenue, South Shields, Co. Durham, to whom they should be returned as soon as possible.

D. R. BARRACLOUGH,
Director of Education.

COMMONWEALTH OF AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH
ORGANIZATION

DIVISION OF LAND RESEARCH AND REGIONAL SURVEY

APPOINTMENT OF CHIEF

Applications are invited for appointment to a position of CHIEF of the Organization's Division of Land Research and Regional Survey located at Canberra, A.C.T., Australia.

The Division's research is concerned with the complex of factors which interact to determine land use potential. Its activities include extensive and comprehensive land surveys of both developed and undeveloped regions, agricultural research in type localities and research in related basic sciences, such as geomorphology, hydrology, climatology, and plant ecology. The annual budget of the Division is at present approximately £A170,000 and the Division has a professional staff of 38, including 29 in the research classification, and a total staff of 92.

Two survey teams operate on the Australian mainland and one in Papua-New Guinea. In addition, the Division has established four research stations, three of which are in the dry monsoonal region of northern Australia. The Katherine Research Station in the Northern Territory is concerned with dry land agriculture, the Kimberley Research Station in Western Australia with irrigated agriculture, and the Coastal Plains Research Station near Darwin, mainly with research into rice production. The fourth station, at Alice Springs in the centre of Australia, undertakes arid zone research. All the Division's activities are co-ordinated to develop better understanding of land as a complex, and the significance and interactions of individual factors.

SALARY—not less than £A4,902 p.a.

Fares paid. Further details on this and other conditions supplied on application to:—

Mr. E. J. Drake, Chief Scientific Liaison Officer,
Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2.

to whom applications (quoting Appointment No. 570/84) should be addressed by the 21st MAY, 1960.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the following posts in the Department of Physics

(a) **LEVERHULME FELLOW AND LECTURER:**

The initial salary will be within the range £900-£1,650 per annum, according to qualifications and experience. The post is a special research post with limited teaching duties. It is hoped to fill the post either with an Experimental Physicist or a Theoretical Physicist who is prepared to work in conjunction with experimental teams, helping them with their problems. A good knowledge of Nuclear Physics is essential.

(b) **FOUR POSTS OF LECTURER:** For three of the posts the initial salaries will be in the range £900-£1,650 per annum, according to age, qualifications and experience.

(i) To develop electronic instruments for applications in nuclear physics. The work will include the development of multi-track magnetic tape data stores, pulse amplitude analysers and data handling equipment for computer input. Alternatively the successful applicant may wish to undertake development work on the department's synchro-cyclotron or other accelerating machines.

Applicants must be honours graduates in either physics or electrical engineering and have had practical experience in digital electronics or be familiar with R.F. power systems.

(ii) For normal teaching duties in experimental physics and research in nuclear physics.

(iii) For normal teaching duties in experimental physics and research in acoustics, preferably in the audio-frequency field.

ONE POST OF LECTURER:

Initial salary will be in the range £900-£1,250; for normal teaching duties and research in nuclear physics. Applications, stating age, academic qualifications and experience, together with the names of three referees, quoting ref. CV.NS., should be received not later than 5th April, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained.

THE DURHAM COLLEGES
in the University of Durham

Applications are invited for the post of LECTURER IN PHYSICS from 1 October 1960.

Applications (three copies), together with the names of three referees, should be sent not later than 23 April 1960, to the Secretary, 38 North Bailey, Durham, from whom further particulars may be obtained.

UNIVERSITY OF
THE WITWATERSRAND
Johannesburg
LECTURER IN DEPARTMENT
OF GEOLOGY

Applications are invited for appointment to the above post. Special qualifications in Engineering Geology, including Hydrology and Soil Science, will be a strong recommendation. Duties to be assumed on 1st July, 1960, or as soon as possible thereafter.

The salary will be according to the scale £230 x 60-£710. A commencing salary above the minimum notch may be paid on the grounds of special qualifications or experience. In addition, the University is at present endeavouring to pay an annual vacation savings bonus of up to £60 in September each year.

Membership of the University Institutions Provident Fund is compulsory and membership of the University's Staff Medical Aid Fund is compulsory in the case of an officer who is found eligible in terms of the rules.

Intending applicants are advised to obtain a copy of the Information Sheet relating to this vacancy from the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in South Africa and London, on 15th APRIL, 1960.

NORTHAMPTON COLLEGE
of Advanced Technology
St. John Street, London, E.C.1

APPOINTMENT OF

HEAD OF DEPARTMENT
OF OPHTHALMIC OPTICS

The Governing Body invites applications for the HEADSHIP of the Ophthalmic Optics Department, which provides full-time and part-time courses for the education and training of ophthalmic opticians and is concerned with an expanding field of post-graduate courses and research.

Applicants should have qualifications in ophthalmic optics or physics.

The SALARY scale is £1,950 rising by annual increments of £50 to £2,100 per annum, plus a London Allowance of £36 increasing to £51 at the age of 37. The post is pensionable.

Further particulars and forms of application obtainable from the Secretary of the College.

OFFICIAL APPOINTMENTS—contd.

NATIONAL RESEARCH COUNCIL,
CANADA

Division of Building Research

SCIENTIFIC RESEARCH OPPORTUNITY

The Division of Building Research, National Research Council has an opening for a CHEMIST or CHEMICAL ENGINEER to assume responsibility for cement and concrete research in the Division. The research studies will embrace studies on the properties and use of concrete materials in well equipped laboratories located in Ottawa.

Candidates should hold a Master's degree from a recognized university and have from 3 to 5 years' experience in the cement or concrete field.

Salary will depend on education and experience. Applications and requests for further information should be addressed to:

Employment Officer,
National Research Council,
Ottawa 2, Ontario,
Canada.

IMPERIAL COLLEGE OF
SCIENCE & TECHNOLOGY
PHYSICS DEPARTMENT

Applications are invited for the following posts in the photo-electronics section:

1. LECTURER Salary in range £900 x 50 to £1350 (bar) x 175 to £1650 per annum, plus £60 per annum London Allowance and Family Allowance of £50 per annum per child. F.S.S.U. membership. Duties include teaching General Physics and special Advanced Course, research in application of physics to electronics in nuclear physics, astronomy, space research, etc.

2. RESEARCH ASSISTANT (Academic) to carry out research in the fields of vacuum physics and photo-electronics. A good degree essential and some research experience preferable. Salary in range £700 to £1000 per annum depending upon qualifications. F.S.S.U. membership.

Apply, with full personal and academic details and names of two referees, to: Professor D. J. McEwen, Physics Department, Imperial College of Science & Technology, London, S.W.7.

IMPERIAL COLLEGE OF
SCIENCE & TECHNOLOGY

Applications are invited from PHYSICAL CHEMISTS for appointment as LECTURER in the Department of Electrical Engineering. Candidates should have postgraduate research experience and preferably a Higher Degree. The successful applicant will work in a research group investigating the properties of materials with facilities for pursuing his own line of research within this general field. Experience in electronics would be an advantage.

Appointment would be made within the salary range £900 x £50 to £1350 (bar) x £175 to £1650 per annum with F.S.S.U. benefits and London and Family Allowances. Three copies of application, giving full particulars and experience and including the names of two referees, should be sent before 31 March 1960 to Professor A. Tustin, Department of Electrical Engineering, Imperial College of Science & Technology, London, S.W.7.

The United Birmingham Hospitals

THE QUEEN ELIZABETH
HOSPITAL
Edgbaston, Birmingham, 15

Applications are invited for the following posts:—

- TECHNICIAN. Candidates should have experience in a Physics Laboratory and preferably hold an ordinary National Certificate or equivalent qualification. Salary scale £495 rising to £625 per annum.
- SENIOR TECHNICIAN (ELECTRONICS) to be responsible for the maintenance and repair of equipment in the hospital generally, and to construct and collaborate in the development of electronic instruments. Good experience in this field essential. Salary scale £625 rising to £810 per annum.

Whitley College of Science and Technology. Applications giving details of qualifications and experience, together with names of two referees, to be sent to the House Governor, from whom further particulars may be obtained if desired.

WARWICKSHIRE EDUCATION
COMMITTEERugby College of Engineering
Technology

Applications are invited for the post of PRINCIPAL of the RUGBY COLLEGE OF ENGINEERING TECHNOLOGY, which is at present concerned almost exclusively with full-time sandwich courses leading to the Diploma in Technology (Engineering), B.Sc. (Engineering) or College Diploma. High standards of qualifications, not essentially in Engineering Sciences, and responsible administrative experience at this level of education are essential.

Further particulars and application forms, to be returned by the 31st April, 1960, from undesignated.

N. A. Y. YORKE-LODGE,
County Education Officer

THE MANCHESTER COLLEGE OF
SCIENCE AND TECHNOLOGY
(Faculty of Technology in the University of Manchester)Appointment of
LECTURER IN METALLURGY

Applications are invited for the post of Lecturer in Metallurgy with the title and status of Lecturer in the University of Manchester. Salary according to qualifications the scale £900 x £50-£1350 x £75-£1650. Superannuation under the F.S.S.U. Family Allowances. Excellent facilities: Metallurgical Analysis, Refractories, Non-Ferrous Extraction, Physical Metallurgy.

Conditions of appointment and application form may be obtained from the Registrar, The Manchester College of Science and Technology, Manchester, 1, to whom applications must be returned by Saturday, 2nd April, 1960.

LIVERPOOL REGIONAL
RADIOTHERAPY CENTREClatterbridge Hospital West,
Bebington, Wirral,
Cheshire.

Applications are invited for the post of SENIOR PHYSICIST from graduates with previous experience in radiotherapy physics. This deterministic post, with a staff of four physicists and five physics technicians, offers good facilities for work in conjunction with modern radiotherapy equipment (including a 4 MeV Linear Accelerator) and also increasing opportunities in general medical physics. Salary Scale: £1,440-£1,550 p.a. Form of application from Secretary, Group Headquarters. (596.)

THE UNIVERSITY OF LEEDS

Department of Botany—
Biophysics Subdepartment

Applications are invited for a research worker to collaborate on biochemical and biophysical problems associated with changes in the fine structure of timber on decay by microorganisms. High academic qualifications and previous research experience essential, in some relevant field such as biochemistry, mycology, microbiology etc. Appointment for three years at least from a starting date to be arranged, at salary within the range £700-£1,000 per year. Applications giving details of the names of two referees should be sent to the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) as soon as possible and not later than 30th April, 1960.

UNIVERSITY OF ST. ANDREWS

Applications are invited for a LECTURESHIP IN ASTRONOMY in St. Salvador's College, University of St. Andrews.

The appointment will be made from candidates with research experience in the theory of stellar atmospheres and interiors, or in photographic and photometric photometry, or in optical and electronic instrumentation. Astronomical knowledge is desirable. Commencing date of the appointment is 1st October 1960. Salary scale £900 to £1650, starting salary according to qualifications and experience in teaching and research. F.S.S.U., family allowance, grant towards removal expenses. SIX copies of applications, with the names of three referees, should be sent with the Joint Clerk to the University Court, The University, St. Andrews, from whom further particulars may be obtained, not later than 16th April.

UNIVERSITY OF HONG KONG

ASSISTANT LECTURESHIP
IN PHYSIOLOGY

Applications are invited for the above-mentioned post.

Initial salary (superannuable) is £1,375 x £50-£1,525 for a man or £1,040 x £40-£1,160 for a woman. There is also an expatriation allowance of £225 a year if applicable. Income tax in the Colony is comparatively low.

First-class sea passages are provided for expatriate staff and their families on first appointment and leaves. Accommodation at reasonable rate is provided for those receiving expatriation allowance.

Further particulars and information as to the method of application may be obtained from the Secretary, APPLICATIONS OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in Hong Kong and London, on 29th April, 1960.

NORTHERN POLYTECHNIC,
Holloway, London, N.7.

The Governing Body invites immediate applications for appointment as LECTURER in COMMUNICATIONS to teach up to the Full Technological Certificate of the City & Guilds of London Institute and the Second B.I.R.E. Applicants should have specialised in Television transmission and reception systems and preferably have had some practical experience of a major research and development organisation. Facilities available for research include: £1,510-£1,510-£40 x £40 x £1,550, together with allowances in accordance with the Bournemouth Award.

Apply for further particulars and form of application.

R. H. CURRELL, F.C.A.
Clerk.

SPACE RESEARCH BY ROCKETS
AND SATELLITES

Vacancies exist in Space Research Group in Physics Department, University College, London (Governing Body: Sir Harrie Massey, F.R.S.), for the following personnel: SENIOR RESEARCH ASSISTANT (post-doctorate physicist) to undertake research in rocket and satellite; SENIOR RESEARCH ASSISTANT (post M.Sc. or Ph.D. minimum) or physicist to undertake research and to set up and supervise arrangements for data handling (including use of automatic computers); COMBATANTS (female) with advanced level mathematics, G.C.E.; ELECTRONIC TECHNICIAN, with initiative, able to undertake accurate assembly of rocket and satellite electronic systems; and to take part in experiment and testing; MECHANIC TECHNICIAN, with initiative and ability to undertake accurate machining, instrument-making and development work.

Applications should be sent to: Dr. R. L. F. Boyd, Dept. of Physics, UNIVERSITY COLLEGE LONDON, Gower St., W.C.1.

The United Birmingham Hospitals

THE QUEEN ELIZABETH
HOSPITAL
Edgbaston, Birmingham, 15

Applications are invited for the post of PRINCIPAL GRADE PHYSICIAN in COMBUSTION (Physics) applied to the various fields of medicine (other than Radiatherapy). Responsibilities of the new section will also include the provision of a research unit in hospitals, a Postal Film Badge service and Safety in Operation Theatre. Technical assistance will be provided. There are opportunities for research and teaching. Candidates should have good experience either in Hospital Physics or in some relevant field (such as Biophysics, Electronics or Nuclear Physics). Salary scale £1,605 rising to £1,920 per annum. Applications giving details of qualifications and experience together with the names of two referees should be sent to the House Governor, from whom further particulars may be obtained if desired.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for a post of COMPUTER MAINTENANCE ENGINEER for a DEUCE computing machine installation. Previous experience of computer maintenance not essential, but a knowledge of computer design, or of pulse techniques as applied to radar would be advantageous. Initial salary £650-£800 or £800-£1,000 per annum according to qualifications and experience. Further particulars and forms of application may be obtained from the Registrar, The University of Liverpool, from whom applications may be forwarded as soon as possible quoting reference CV/NS.

OFFICIAL APPOINTMENTS—contd.

TROPICAL PRODUCTS INSTITUTE, D.S.I.R., London, requires **EXPERIMENTAL OFFICERS** (AST), E.O., to assist in pilot testing and advisory work of Fibres Section, and in more fundamental research work on origin of natural spinning. Minimum qualifications—(a) C.E. A. Level in physics and another science or maths subject or equiv. Over 22. Pass degree in physics or equiv. generally expected. Experience of test methods, textile processing and/or electronics an advantage. Age at least 26 for E.O. Salaries—(Men) E.O. £1,005-£1,253. A.E.O. £1,397-£1,650. Forms from Ministry of Labour, Technical and Scientific Section (K), 26, King St., London, S.W.1. Quote A125/OA.

NATIONAL PHYSICAL LABORATORY, Teddington, Mdx., requires **SCIENTIFIC OFFICERS**. SENIOR S.O.'s in Basic Physics Divn. to do fundamental research on physical and chemical properties of solids at very high pressures. Previous research experience in some experimental branch of physics, chemistry or engineering required. Quals.—1st or 2nd Class Hons. degree. At least 3 years' post-graduate experience required for S.S.O. Salaries—(Men) S.O. £655-£1,150, S.S.O. £1,233-£1,460. Forms from Ministry of Labour, Technical and Scientific Section (K), 26, King St., London, S.W.1. quoting A119/OA. Closing date 30 April 1960.

APPOINTMENTS AND SITUATIONS VACANT

7s. per line—Box Number 1s. extra

MIDDLESEX COUNTY COUNCIL

ASSISTANT CHEMISTS required at Moyden Purification Works, Isleworth. Salary according to qualifications and experience within N.C. Special £75-£110/0 or APT II £78-£100 or APT I £60-£75. London. Weighing up to £30 payable in addition. Established Prescribed conditions. Written applications (2 references) to Chief Chemist, P.O. Box No. 7, Isleworth (Quote C 109 N.S.).

B.B.C. requires **WORK ANALYST** (preferably in early 30's) in its Central Establishment Office, for study of organization, procedures, work methods, staffing and job duties throughout the Corporation. Requirements are a qualification (preferably in science or technology) from a University or professional institution, together with some three years' experience in Work Study (particularly Methods Study) or equivalent fields. The work requires high personal qualities, including an enterprising, analytical mind, sound general interests, and an understanding approach to working relationships among people of widely differing backgrounds. This is an interesting post with good prospects of promotion to a more senior position. Salary £1150 (possibly higher if qualifications exceptional) rising by five annual increments to £1970 max., p.a. Requests for application forms (enclosing addressed envelope and quoting reference, 60 C 130 N.S.) should reach Appointment Officer, Broadcasting House, London, W.1, within five days.

HEAD OF METALLURGICAL RESEARCH DEPARTMENT

It is desired to appoint a Head of the Metallurgical Department of a well known organisation with interests in both fundamental and applied research. The post will appeal to a young man, starting about £3,000-£2,000 who has already given proof of leadership and abilities to carry out and direct research and who will shortly be looking for further substantial advancement.

The successful candidate will have unusual freedom to organise and develop his own lines of work and ample opportunity for publication and participation in the advancement of metallurgical and allied scientific societies. The post can fairly be described as one of exceptional opportunity.

Applications in strict confidence to Box No. C 478, THE NEW SCIENTIST.

SECRETARY

Managing Director of important British pharmaceutical manufacturers with Offices in London requires a Secretary with the following special qualifications. She should (a) have a B.Sc. degree in Chemistry; (b) have taken a business training course and be a competent shorthand typist; (c) preferably have had some secretarial or other business experience. The commencing salary will be commensurate with the responsibilities of the position and will take into account age, qualifications, experience, etc. Write fully to Box No. C 480, THE NEW SCIENTIST.

THE POLYTECHNIC
309 Regent Street, W.1DEPARTMENT OF MATHEMATICS
AND PHYSICS

Applications are invited for two full-time posts

- (a) as a LECTURER in Mathematics;
(b) as a GRADE B TEACHER in Mathematics;

desires to commence on the 1st of September, 1960.

Candidates should possess a good honours degree in Mathematics and be able to lecture on the subject up to degree standard.

Previous lecturing or industrial experience is desirable, especially for post (a).

The salary scale for a LECTURER commences at £1,370 per annum rising by annual increments of £35 to £1,550 plus London allowance of £38 or £51 per annum.

The salary scale for a GRADUATE GRADE B TEACHER commences at £700 per annum rising by annual increments of £27 10s. to £1,240 plus London allowance of £38 or £51 per annum. Additional allowances are payable in respect of a good honours degree and training. A form of application, which should be returned not later than 25th March, 1960, may be obtained by sending a stamped addressed inloacp envelope to the undersigned.

J. E. RICHARDSON
Director of Education.

BIOCHEMIST interested in biological assay work in connection with cancer research. Salary on Whitley Council scale. Please apply with details of qualifications and experience, together with the name of a referee, to the House Governor, ROYAL MARSDEN HOSPITAL, Fulham Road, S.W.3.

THE UNITED STEEL COMPANIES LIMITED

THE UNITED
STEEL
COMPANIES LTD

OPERATIONAL RESEARCH
AND CYBERNETICS

United Steel is the largest producer of steel in the country. It has in turn the largest O.R. group in the country: the Department of Operational Research and Cybernetics. The Department's headquarters, Cybor House, is in the residential outskirts of Sheffield, close to the surrounding countryside.

We have vacancies, at all levels below the Head of Department, to which men (or women) with experience will be appointed. These levels are designated: Manager; Senior; Scientist (senior); Scientist (junior). Salaries cover an appropriately broad range.

Enquiries, which will be treated in complete confidence, are invited from those with a knowledge of the application of science to problems of management and control. We shall require evidence of experience in either O.R. or cybernetics, or in any cognate activity such as computer programming or technology, systems analysis (including electronic systems), econometrics, work study or ergonomics.

The problems dealt with are difficult, diverse and challenging. However, members of the Department work in comfortable conditions with tractable colleagues under adaptable terms. Facilities include a Pegasus computer (on which much pioneer work has already been done), an electronic laboratory (specialising in decision-making machines), a library and staff dining-room.

Write for further information and application forms to:

The Administrative Officer, Cybor House, 1 Tapton House Road, Sheffield, 10.

or, if you prefer, a letter marked PERSONAL to the Head of Department.

ASSISTANT
ENGINEER

E.M.I. Electronics Ltd. has a vacancy in its Valve Division laboratories at Ruislip, Middlesex, for an engineer to assist in carrying out interesting work on high vacuum valves. Applicants should be young, with at least H.N.C. in physics. Some relevant experience together with a knowledge of chemistry would be advantageous.

Please write giving full details and quoting Ref. EL/6213 to:

Personnel Manager
E.M.I. ELECTRONICS LTD.
HAYES, MIDDLESEX.

TECHNICIAN or JUNIOR TECHNICIAN interested in biochemistry required for biochemical and analytical assay work in Endocrinology Laboratory, National scales of pay. Please apply giving age, qualifications and experience together with the name of a referee to the House Governor, ROYAL MARSDEN HOSPITAL, Fulham Road, S.W.3.

APPOINTMENTS AND SITUATIONS VACANT—contd.

NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING

Borough Polytechnic

Borough Road, London, S.E.1

DIRECTOR: James E. Garvie, M.Sc.Tech., Ph.D.,
F.R.I.C., F.I.M., F.Inst.F.

HEAD OF COLLEGE: David R. Scott, M.Sc., Ph.D.,
M.Inst.R., A.M.I.H.V.E., A.Inst.P., A.M.I.Min.E.,
A.M.E.M.E.

The Governors invite applications for the following appointment:

RESEARCH ASSISTANT

Applicants should be University Graduates in Science or Engineering. Consideration will also be given to those expecting to graduate at the end of this present academic year. Applicants should have a knowledge of Automatic Controls and an interest in Process Control Engineering. Where a candidate's qualifications permit, the results of the research may be used for the purpose of gaining a higher degree. Publication is encouraged. Salary—£600 p.a., and the post is superannuable after an initial period of one year.

Further particulars and Application Form, which should be returned as soon as possible, obtainable from the under-signed.

Fredk. J. Packer,
Clerk to the Governing Body.

CHEMIST

required to undertake research on protective finishes including lacquers for non-ferrous metals. Applicants should have an honours degree and preferably experience in the paint and varnish field. Age not over 40. Initial salary in the range £1,000 to £1,500. Write: Secretary, B.N.F.M.R.A., Euston Street, London, N.W.1.

UNIVERSITY OF NOTTINGHAM

Department of Botany

Applications are invited for an ASSISTANT LECTURERSHIP IN BOTANY. Preference will be given to candidates interested in Bryophyta, Pteridophyta and Gymnosperms, who have had research experience in some aspect of one or other of these groups. Salary within the scale £700 a £950 to £850, with membership of the Universities' Superannuation Scheme and children's allowances. Conditions of Appointment and Form of Application, to be returned by 14th April, from the Registrar.



SALARIES

will be between £2,400 and £2,900 according to qualifications and experience

Contributory Superannuation.

Housing will be available.

APPLICATIONS

Write for application form, quoting appropriate reference number, to: Group Recruitment Officer.

DEVELOPMENT AND ENGINEERING GROUP

U.K.A.E.A.

Risley, Warrington, Lancs.
Closing Date: 14th April, 1960

NCR

ELECTRONICS

Opportunities for Programmers

The imminent release of a new static solid digital computer of advanced design has created important openings in the Programming field. NCR Electronics offer you the opportunity of joining now a team actively engaged on challenging development work:

Business System Programmers — with Honours Degree in Mathematics (or allied subject) plus at least 2 years of success in writing programs for commercial digital computers.

Mathematician Programmers

— with 1st or 2nd Class Honours degree in Mathematics — plus considerable experience in writing mathematical routines and a broad knowledge of numerical analysis.

Specialists in Automatic Coding Systems

— with experience in the design of autocode systems plus evidence of having written successful programs for data processing applications.

Specialists in Diagnostic Routines

and Engineering Test Programs — with a comprehensive knowledge of logical design and computer operations, plus the ability to co-operate with maintenance engineers in the designing of test routines.

For a strictly confidential interview (with NCR Electronics Management), please submit details of your background and qualifications to The Manager, NCR Electronics.

The National Cash Register Company Limited
506-218 Marylebone Road - London W1

Assistant Chief Engineers

DUTIES

Post 1 (Ref. 206/J17)—To control the work of several sections engaged on the design of large chemical projects. The work will include novel and conventional engineering problems arising from the use of special materials and will involve provision for the remote operation of plant and equipment as well as design of associated laboratories and services.

Post II (Ref. 207/J17)—To control the work of several sections engaged on the design of metallurgical and mechanical engineering plant installations. The plants are required to handle unusual metals involving the design of new equipment for vacuum casting, pressing, rolling, heat treatment, machining, welding and powder metallurgy processes.

QUALIFICATIONS AND EXPERIENCE

All applicants must have served a recognised engineering apprenticeship and be corporate members of a senior engineering institution or have equivalent qualifications.

For Post I considerable experience of work at a senior level on high quality mechanical or chemical engineering design is essential and possession of an honours degree in either of these may be an advantage.

For Post II considerable design experience at a senior level in a similar field, but not necessarily in nuclear engineering, is essential. Some experience of constructional work and of plant installation would be an advantage.



DIRECTOR OF RESEARCH (Eastern United States)

A brief statement of
qualifications and experience
should be sent to
Mr. David Young, marked (NS) 781, at

MOUNT VERNON HOSPITAL Northwood, Middx.

SENIOR TECHNICIAN II required for Cancer Research Laboratory. Work in connection with cytology and cytotoxicity of human tumours. Some organic ability required and previous experience in medical or biological research an advantage. Salary scale £760-£960 per annum plus London Weighting. Applications giving age, experience and names of two referees to Administrative Officer.

FIELD STUDIES COUNCIL

SLAPTON LEY FIELD CENTRE
Slapton, Nr. Kingsbridge, Devon

Applications are invited for the post of **FIELD ASSISTANT (Male)** at Slapton Ley Field Centre, appointment to date from mid-July or as soon after as possible. Applicants should have an Honours degree in Zoology, Subsidiary Botany and/or Geography desirable.

Salary £300 per annum with full residential benefits. The appointment will be for one year in the first place. This is primarily a teaching appointment but there are reasonable opportunities for private study and research. Applications should be sent (in triplicate) naming two referees and stating age, qualifications and experience of field work to the Secretary, Field Studies Council, 9 Devereux Court, Strand, London, W.C.2.

THERE is a vacancy for a man of up to 30 with a degree or equivalent in CHEMISTRY to do research in the field of natural products in a laboratory about twenty miles north of London. Some laboratory experience is essential. Starting salary will be in the range £650-£850 p.a. and the conditions of employment are attractive. Reply in Box No. CR.4, c/o Dawson, 28 Craven Street, W.C.2.

ANOTHER OPPORTUNITY IN IRON AND STEEL

BISRA ELECTRICAL ENGINEER or PHYSICIST

ELECTRIC ARC FURNACES are rapidly becoming major contributors to the increased supply of steel required by our expanding economy. Continued progress will depend on the extent to which operation is scientifically controlled. BISRA has already advanced knowledge in this field and the results are now being applied.

The Steelmaking Division in Sheffield wishes to expand its efforts and is looking for a **GRADUATE ELECTRICAL ENGINEER or PHYSICIST** to complete a team developing control and automation procedures to be applied to production furnaces and studying the behaviour of high current arcs so that thermal efficiency may be improved.

Applicants should be up to 30 years of age; the successful applicant will be paid a salary commensurate with his experience and qualifications. Written applications only, quoting "S.M.9." to the Personnel Officer, The British Iron & Steel Research Association, 11, Park Lane, London, W.1.

Executive Selection Service is advising on the following appointment:

A young progressive organisation in the United States, with a staff of highly qualified scientists, engaged on research and development work in direct energy conversion, with a special emphasis on thermionic power generation, is seeking a Director of Research to co-ordinate and administer this work. The post is an exacting one and will be filled by a man of outstanding ability and character able to direct the efforts of an export team. His experience should include high vacuum techniques and ceramic bonding as well as the administration of a first class research department. He should have an Honours Degree and be between 35 and 45 with some years' industrial as well as academic experience. A salary in the region of £20,000 is contemplated with opportunities for participating in the future prosperity of the organisation.

As this is a confidential service, the names of applicants will not be disclosed without their agreement.

Associated Industrial Consultants Ltd BUSH HOUSE, London, W.C.2.

A TECHNICIAN, who should have experience of abnormal electronic techniques and preferably also of transistor circuits, is required for work on an experimental project based on Leeds University and with the main experimental work at a field site at a distance of 15 miles. Ability to drive will be an advantage, and ability to keep careful records will be essential. The appointment will in the first instance be for three years and the salary offered will be related to the qualifications and experience of applicants. Further details may be obtained from the Secretary, Physics Department, UNIVERSITY OF LEEDS, to whom applications should be addressed and should reach her not later than 15th April.

SCOTTISH HOME DEPARTMENT, MARINE LABORATORY, ABERDEEN. SCIENTIFIC OFFICER. Un pensionable post (male) for scientist interested in the fishing industry, to join a team studying fishing gear and its modifications to increase fishing efficiency. Work will include investigation of the uses of natural and synthetic fibres. Post involves sea duty. First or second class honours degree in engineering or physics or equivalent required. Age 21-28 up to 1.1.60. Salary scale £355-£1,120, starting above minimum in some cases. Opportunities to gain pensionable post. Particulars and application form from Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh, 1. Applications to be returned by 9th April, 1960.



NEW COMPUTER TECHNIQUES

A new division has recently been formed to promote the further development of **Advanced Computer Techniques** including **High Speed Storage and Logic**. A number of vacancies remain to be filled. This is a unique opportunity for top class Engineers and Physicists to join and share in the growth of an expanding new division.

The positions yet to be filled are:

- 1 TEAM LEADERS:** Two Graduate Engineers with considerable experience of **Ferrite Core Storage and Transistor Pulse Circuits**.
- 2 SENIOR ENGINEERS:** Five Graduate Engineers with experience of **Ferrite Core Storage or Transistor Pulse Circuits**.
- 3 POWER SUPPLY ENGINEER:** To specialise in the design and construction of power supplies for **Transistor Digital Computers**. Previous experience of power supply design essential.
- 4 TEST EQUIPMENT ENGINEER:** To specialise in the design, construction and maintenance of special test equipment for **Computers**. Knowledge of **Transistor Pulse Circuits** and considerable practical experience is required.
- 5 JUNIOR ENGINEERS:** A number of Engineers (Graduates or H.N.C.) preferably with some experience of **Transistor Pulse Circuits** and an interest in **Computers**.

The posts are located within easy travelling distance of Central London and carry attractive, progressive salaries combined with excellent conditions of employment, with good prospects of advancement. Applicants are invited to write in confidence to the:

PERSONNEL OFFICER:

MULLARD RADIO VALVE CO., LTD.

NEW ROAD, MITCHAM JUNCTION, SURREY

Quoting reference JFG/NS

"Mullard" is the trade mark of Mullard Limited

APPOINTMENTS AND SITUATIONS VACANT—contd.

SCIENTIFIC ASSISTANTS

required by

**THE ATOMIC WEAPONS RESEARCH
ESTABLISHMENT, ALDERMASTON,
BERKSHIRE.**

These posts provide training in experimental and research techniques for young men and women wishing to enter a scientific career in Physics, Mathematics or Chemistry.

Current vacancies include a number of posts providing assistance to more senior staff in: Biological Assay Work, Mathematical Laboratories, Chemical Technology, Applied Physics and Chemistry.

Successful candidates will attend a training course and will be actively and financially encouraged to obtain further qualifications.

Good prospects, whether your scientific interest is theoretical or more practically inclined.

Candidates (age 16-26) should have G.C.E. in four subjects, including English Language and a scientific or mathematical subject. Students who hope to obtain these qualifications in the near future may apply.

SALARY: £335 (age 16-£740).

Superannuation Scheme (from age 18).
Modern Hostel.

Please write for application forms to the Senior Recruitment Officer, at above address. Please quote ref. 2549/215.

Presentation of Technical Information

GKN

The Group Research Laboratory requires an

ASSISTANT IN THE LIAISON AND INFORMATION DIVISION

who will be responsible for the production of progress reports and the editing of a technical review, which is distributed throughout the Group of some 80 companies engaged in the making of steel and many forms of engineering.

Applicants must have some technical knowledge and be able to present technical information in an interesting and understandable form.

Applications, giving age, salary, details of career to date, and quoting reference L/1, should be addressed to the Recruitment Officer, G.K.N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton.

EXPANDING Flexible Packaging Converters in the North-West require Graduate or equivalent for development work on the extrusion of thermoplastic materials in sheet, or as an extruded coating on to fibrous and non-fibrous substances. Salary according to qualifications and experience. Apply, giving full details, to Box No. C.472, THE NEW SCIENTIST.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PAINTS DIVISION

has immediate vacancies for

LABORATORY ASSISTANTS

These positions offer excellent opportunities for both boys and girls who have taken the General Certificate of Education in Chemistry, Physics and Mathematics at Advanced Level, and passed in at least Chemistry, although those with passes in all these subjects at Ordinary Level will also be considered.

Every encouragement is given to entrants to continue their studies. Assistance given with accommodation where necessary.

Apply in writing to:

The Staff Officer,
I.C.I. PAINTS DIVISION,
Wexham Road, Slough, Bucks.

ANOTHER OPPORTUNITY IN IRON AND STEEL

BISRA CHEMIST or CHEMICAL ENGINEER

OXYGEN is revolutionising the production of steel and the limits to which it will speed up refining procedures are not yet in sight. The Steelmaking Division of BISRA is engaged in investigations in steelworks and on pilot plants to discover these limits and develop new techniques for using this gas that will be rapid, efficient and economic in operation.

The Division invites applications from GRADUATE CHEMISTS or CHEMICAL ENGINEERS to fill a vacancy in the team working in this important field. Familiarity with the handling of liquids, gases and powdered solids would be an advantage but not essential.

Applicants should be up to 30 years of age; the successful applicant will be paid a salary commensurate with his experience and qualifications.

Written applications only, quoting "S.M.10," to the Personnel Officer, The British Iron & Steel Research Association, 11, Park Lane, London, W.1.

SOLARTRON

SENIOR SYSTEMS DESIGN ENGINEERS

We have two immediate vacancies for Senior Systems Design Engineers to work in the combined fields of Data Handling and goods transference for a new Company jointly owned by Solartron and John Brown Limited. Their work will be initially in connection with

AUTOMATIC WAREHOUSING

involving mechanical handling of goods, electronically-controlled and programmed to meet incoming order requirements.

A SENIOR SYSTEMS DESIGN ENGINEER

to study customers' existing systems and to propose schemes for the integration of these systems with automatic warehousing and self-service installations. A knowledge of Organisation and Methods techniques is required, and particularly experience in mechanical handling systems, together with the ability to prepare proposals and to estimate systems costs. (Ref. 252)

A SENIOR SYSTEMS DESIGN ENGINEER

to assess economic optimum conditions of automation in the above fields, and to produce block schematics, proposals and estimates of systems costs for the electronic control, programming and associated data handling. He will work together with Planning and Production Engineers throughout manufacture, test and installation. Successful candidates should, therefore, be familiar with business data handling methods and have experience in electronic logic design and in estimating both for our own manufacture and sub-contracted items. (Ref. 253)

The appointments will be initially at Fareborough, Hampshire, and later in London. These are senior positions and command corresponding salaries



Please write to Eric Bull, Personnel Officer

SOLARTRON ELECTRONIC GROUP LTD.

FAREBOROUGH, HAMPSHIRE

Hawker Siddeley Aviation LIMITED

Due to an expanding programme of work on guided missile projects

THE RESEARCH GROUP OF

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD. ARMAMENTS DIVISION

invite applications from graduate

ENGINEERS, MATHEMATICIANS, PHYSICISTS, STATISTICIANS AND AERODYNAMICISTS

for the following positions:

1. PERFORMANCE INVESTIGATIONS

Candidates for this position should possess a degree in Mathematics, Mathematical Physics or Statistics and a sound grasp of one or more of the following branches:—

Probability Theory—Statistics—Numerical Analysis—Operational Calculus.

The successful applicant would be expected to investigate a wide range of mathematical and statistical problems on missile performance. Computer facilities will be available and if it is found necessary, programming training will be provided.

2. DIGITAL PROGRAMMING

Candidates for this position should possess a degree in Mathematics or Physics and preferably scientific programming experience, though this is not essential as training will be provided if necessary.

The successful applicant would be engaged mainly on digital programming in connection with advanced performance calculations, though other mathematical techniques will be required.

3. MISSILE AERODYNAMIC AND AEROELASTIC INVESTIGATIONS

Candidates should possess a degree in Aerodynamics, Physics or Mathematics and preferably have some experience relevant to the vacancy.

The three positions vacant are:—

(a) For work on theoretical aeroelastic problems.

(b) For digital programming work at intermediate level in connection with aeroelastic and kinetic heating problems. Some digital programming experience is desirable, but otherwise full training will be given.

(c) For aerodynamic interference problems in the supersonic and hypersonic regimes.

4. MISSILE SYSTEM ANALYSIS

Candidates should possess a degree in Mathematics, Physics, Electrical or Aeronautical Engineering or the equivalent.

The work consists of theoretical systems analysis investigations of an advanced nature on the performance and stability of guided weapon systems. The problems are studied on one of the largest and most successful analogue computers in the country. Another computer of similar capacity is now becoming available, and in addition many of the simulations are completed in parallel on a Pegasus digital computer.

The two positions vacant are:—

(a) Section Leader to lead a small team of graduates and assistants and have at least 2-3 years' experience on simulators, missile systems analysis or servo design.

(b) A more junior position suitable for candidates between 21 and 25 years with an interest in systems study work, although not necessarily having previous experience.

Substantial salaries will be paid to well qualified candidates with experience in one or more of the above subjects.

The Company's research organisation is set in rural surroundings at Whitley, nr. Coventry, within easy reach of the city centre.

Applications will be treated in the strictest confidence, and should be addressed to:

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LIMITED
BAGINTON, N. COVENTRY.

Quoting reference number T.A.O./ARM/RES/13.

GUIDED WEAPONS

A. V. ROE & CO. LIMITED

Weapons Research Division, Woodford, Cheshire

TRIALS ANALYSIS GROUP

There are three senior vacancies available for staff to supervise the analysis of the results obtained from the flight trials of guided missiles.

The work of the Group includes the investigation of problems on flight dynamics, supersonic propulsion systems, and the behaviour of automatic control and guidance systems.

Extensive computing and data reduction equipment is operated by the Group and the services of a large electronic computer are available.

There are immediate vacancies for

AERODYNAMICIST (1 post)

ELECTRONIC ENGINEERS (2 posts)

Qualifications: 1st or 2nd class Honours Degree in an appropriate subject.

Experience: At least 3-5 years' experience in industry or a research establishment.

Applications with full details and quoting reference No. R.95/N should be sent to the address below.

The Division is situated in Woodford, Cheshire, in pleasant surroundings with good housing and shopping facilities and a Hawker Siddeley Group pension scheme is operated.

**Chief Engineer, Weapons Research Division,
A. V. ROE & CO. LIMITED, Woodford, Cheshire**

There is also a vacancy for a

SECTION LEADER

to head the Trials Design and Planning Section.

This section is responsible for the theoretical design and planning of guided missile air experiments and offers an exceptional opportunity for a well qualified senior man to obtain a broad view of the guided missile technology.

A knowledge of either electronics or instrumentation or aerodynamics is essential and experience of the mathematical planning of large scale experimental research programmes would be an advantage.

Qualifications: A first or second class honours degree in Mathematics or Physics.

Experience: At least 5 years' experience in industry or a research establishment.

Applications with full details and quoting Ref. No. R.96/N should be sent to the address below.

APPOINTMENTS AND SITUATIONS VACANT—contd.



PHYSICISTS AND ELECTRONIC ENGINEERS

The Research Laboratories of E.M.I. Ltd., have several vacancies for Physicists and Engineers to engage in research projects associated with the following:—

Acoustics with particular reference to problems of magnetic tape recording and of stereophonic recording.

Colour Television with particular reference to circuit research.

Microwave Valves.

Solid State Physics with special reference to photo-electric and photo-conductive.

Applicants should have a good honours degree in physics or engineering and preferably a Ph.D. or research experience. The nature of the previous experience is relatively unimportant; much greater weight is attached to the ability to think originally.

Applicants should apply, with full details and quoting Ref. RES/V/1, to:

**Personnel Manager,
E.M.I. LTD.,
HAYES, MIDDLESEX.**

RADIO MECHANICS. Permanent and pensionable vacancies exist for young men experienced in the assembly, installation and testing of HF and VHF telecommunications equipment, preferably in connection with aviation ground services.

Staff will be based at the Engineering Division of the Company, address below, but their main duties will take place overseas for varying periods installing telecommunications equipment. Whilst overseas a generous daily allowance is paid.

Ex-services personnel of fully skilled categories are particularly welcome to apply. Applications to the Personnel Officer, INTERNATIONAL AERADIO LTD., Hayes Road, Southall, Middlesex.

THE MORGAN CRUCIBLE COMPANY LIMITED

requires a

CHEMIST or PHYSICIST

to act as a PROCESS CONTROLLER in the manufacture of CERAMIC RESISTORS at their Norton Works, Worcester.

A man of 30/45 years of age with a Higher National Certificate or equivalent and industrial experience in the ceramic industry would be ideal for this vacancy. Experience in industrial laboratory techniques or the supervision of laboratory staff would be a useful alternative background.

This post offers opportunities in an expanding branch of a large organisation with widespread interests both in this country and abroad. Superannuation scheme—Canteen—transport facilities from Worcester and Pershore. Salary according to age, qualifications and experience.

Apply giving full personal details and particulars of positions held to: The Staff Department, The Morgan Crucible Company Limited, Norton Works, Woodbury Lane, Norton, Worcester.

SCIENTIST required by the National Coal Board for their Laboratory in Cowdenbeath, Fife. Salary, according to qualifications and experience, within the scale £650-£1,110. Candidates should possess a Degree or equivalent qualification in Chemistry, and have experience in general chemical analysis. The duties of the successful candidate will include the analysis of clays for brickmaking, the analysis of water, and the training and supervision of junior staff. Applications, stating age, education, qualifications, experience, present post and salary to Area Staff Manager, West Fife Area, National Coal Board, Church Street, Cowdenbeath, Fife.

BEDFORD COLLEGE (University of London), Regent's Park, N.W.1. Applications are invited for the post of **UNSKILLED LABORATORY ATTENDANT FOR SCIENCE DEPARTMENTS** (full or part-time), vacant immediately. Salary: £5 per week. Applications to the Secretary.



THE BLUE CIRCLE GROUP
OF CEMENT COMPANIES

CHEMICAL TECHNICAL ASSISTANTS

Applications are invited from young men with qualifications not lower than the Ordinary National Certificate in Chemistry or G.C.E. Advanced Level, for analytical work in the Research Laboratories of the Associated Portland Cement Manufacturers Ltd., or in various Works Laboratories.

The Research Department is near Dartford in Kent, within easy access of the S.E. London area and several Works are in the same area. Other vacancies exist in various parts of the country.

Good salaries according to qualifications and experience. Staff profit sharing bonus and pension schemes. Facilities for continued part-time education in appropriate cases.

Applications to the
**DIRECTOR OF RESEARCH,
The A.P.C.M. Ltd.,
RESEARCH DEPARTMENT,
GREENHITHE, KENT.**

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

Two senior posts are to be filled in the RUTHERFORD HIGH ENERGY LABORATORY, HARWELL, of the National Institute for Research in Nuclear Science. The Laboratory provides very large equipment (notably the 7 GeV Proton-Synchrotron NIMROD) for high energy physics research.

HEAD OF SCIENTIFIC AND TECHNICAL SERVICES

Control of agreements with universities.
Administrative and technical services for university physicists using the Laboratory.
Library and information services, conferences and public relations.

REQUIREMENTS

Honours Physics degree, several years' experience in Scientific Administration. Research experience in high energy physics an advantage.

HEAD OF ADMINISTRATIVE AND PERSONNEL SERVICES

Staffing policy and negotiations.
Personnel Administration for staff of scientists, engineers and craftsmen.
Administrative and office services.

REQUIREMENTS

Experience in personnel work in a large organisation.
Graduate preferred.

The starting salary for either post will not be less than £1,800 p.a.
Please send POST CARD for full details, conditions of service and application form to—

**GROUP RECRUITMENT OFFICER (1548/215)
(for Secretary, N.I.R.N.S.)**

**Atomic Energy Research Establishment
HARWELL, DIDCOT, BERKSHIRE**

APPOINTMENTS AND SITUATIONS VACANT—contd.

ASSOCIATED LEAD MANUFACTURERS LIMITED

THE COOKSON HOUSE RESEARCH LABORATORIES of Associated Lead Manufacturers Limited (part of the Cookson-Wall & Lead Industries Ltd. group) require the following senior research workers

1. A **CHEMIST or METALLURGIST** to work on the extraction and refining of antimony and the production of antimony oxide. The successful applicant will:
 - (a) be a physical or inorganic chemist or a metallurgist with a good honours degree and probably a research degree,
 - (b) have had several years' industrial research experience, preferably in the field of non-ferrous metallurgy,
 - (c) be aged 30-40
2. A **CLASSICAL PHYSICIST** to work on a variety of problems including glass polishing, production of dielectric materials and the classification of fine powders. The successful applicant will:
 - (a) have a good honours degree and probably a research degree,
 - (b) have had several years' research experience including some industrial experience,
 - (c) be aged about 30-35

Both the above positions are permanent and offer scope for advancement. The research laboratories are in Wallaseid, within easy reach of the Northumbrian coast and Newcastle upon Tyne. Working conditions are good and salaries will be related to qualifications and experience. Apply to: Research Manager, Associated Lead Manufacturers Limited, Cookson's Antimony Works, Willington Quay, Wallaseid, Northumberland.

SENIOR LABORATORY TECHNICIAN to be responsible for new physics teaching laboratories and lecture demonstrations up to degree level. The position to be taken up as from 1st July or by arrangement. Salary according to University scales plus London Weighting. Applications in writing, giving details of age and experience to Secretary, KING'S COLLEGE, Strand, W.C.2. (Ref. 3066.)

UNIVERSITY COLLEGE OF NORTH WALES, Bangor

APPLICATIONS ARE INVITED from graduates for the post of Research Assistant in the Department of Agricultural Chemistry, to work on organo-metallic complexes in soils and plants. Candidates should hold a degree in Chemistry or Biochemistry.

The appointment will be for three years, on a salary scale £450 to £504.50.

Applications, giving the names of two referees, should reach the undersigned, from whom further particulars may be obtained, NOT LATER THAN THE 29th MARCH, 1960.

KENNETH LAWRENCE,
Secretary and Registrar.

SALES MANAGER with flair for systematic marketing to run Ultrasonic Flow Detection sales. Experience of selling technical products to metal industry essential. Excellent opportunities for qualified man to expand ultra rapidly growing sales. Write full particulars to ALDRIDGE SONSCOPE CO., Sudbourne Rd., S.W.2.

COMPUTER PROGRAMMER (for LEO II)

is required in the Research Department of a diesel and electrical engineering firm. The work covers a wide range of technical problems and the programming section forms part of a mathematical team in which the programme specifications originate. Previous programming experience is desirable, but not essential.

Replies, giving brief resume of qualifications and experience, to Staff Employment Officer, C.A.V. Ltd., Warple Way, London, W.3, quoting Ref. R34G.

Ferranti EDINBURGH

Due to Ferranti's continuous expansion in the fields of ground and airborne radar, instrument and fire control systems and machine tool control, there are immediate vacancies in a wide range of engineering.

DEVELOPMENT ENGINEERS

Mechanical and electrical engineers and physicists are required with experience in any of the following fields: (1) Micro-waves; (2) Servo mechanisms; (3) Precision mechanical engineering; (4) Circuit development (including transistorised circuits) for analogue and digital computers.

Ref. Inst./143.

A particular vacancy occurs for a **servo engineer** in the application of advanced servo mechanisms for high precision machine tool control. The problem is to extend the performance of hydraulic servo mechanisms and their associated transmission and feedback systems beyond present-day standards and represents a challenge for a man with good theoretical and practical experience of servo work.

Ref. CDE/143.

TEST ENGINEERS

Openings occur for engineers with some years' experience in the radar field who are capable of handling the design problems on test equipment for new radar systems.

Ref. TE/143.

SERVICE ENGINEERS

Computer controlled machine tool, co-ordinate positioning and high speed measuring systems.

An electronic engineer is needed with good experience of servo control and preferably of transistorised circuits who will, after training, introduce our equipment to customers and advise on maintenance. This post will involve contact with a wide range of activity from the latest developments in heavy industry to nuclear research in university departments. Some travel overseas might also be involved.

Ref. Tr./143.

Radar and fire control systems. Electronic engineers are required who have up-to-date experience on the servicing of micro-wave radar equipment and instrument engineers who have experience of aircraft instruments and preferably some knowledge of gyroscopic gun sights. These particular openings might be very suitable for ex-service technical officers or senior N.C.O.s.

Ref. Tr./143.

TECHNICAL AUTHOR

A vacancy exists for a Technical Author to work on radar and fire control systems. The successful applicant may also be asked to give courses of lectures on these equipments in our Service School. Some teaching experience would therefore be desirable.

Ref. TA/143.

Senior and Junior vacancies exist in all cases. There are openings for graduates in all the above types of work but those with relevant experience only are also needed. Staff positions with membership of pension scheme and attractive salaries will be offered to suitable candidates. Interviews will be held in either Edinburgh or London. Please reply giving details of training and experience quoting appropriate reference to

PERSONNEL OFFICER

FERRANTI LIMITED

FERRY ROAD, EDINBURGH, 5

MARKET SURVEY DEPARTMENT

Experienced man 32/45 required in Cardiff area by firm of specialised engineers in group of international repute. This is a staff appointment and previous experience is essential. Salary and experience provision scheme.

Write giving full details of history, and salary required to

Box No. 586, 6 ALDFORD ST., W.I.

E.N.M. LTD. invites applications from **ELCTRONIC ENGINEERS** with practical training and experience in circuit design in computer and industrial control systems would be of advantage. The successful candidate, under 35 years of age, and with a degree or equivalent qualification, will be responsible for experimental development work in an expanding company offering good prospects. Apply Personnel Officer, English Numerical Machines Ltd., Queensway, Enfield, Middx.

The United Birmingham Hospitals.

THE QUEEN ELIZABETH HOSPITAL.

Edgbaston, Birmingham, 15.

Applications are invited for the post of **TECHNICIAN** in the Physics Department for general laboratory duties including the use of radioactive isotopes. Salary £435 rising to £620 per annum.

Applications giving details of qualifications and experience, together with names of two referees, to be sent to the House Governor.

CHEMIST good honours degree, age 25-35, with developed interests in laboratory apparatus and instrumentation, and experience of gas chromatography. Interesting, progressive post in charge of development of new equipment and customer demonstration of existing range. Apply in writing, stating salary required, to Technical Director, SHANDON SCIENTIFIC COMPANY LIMITED, 6 Cromwell Place, London, S.W.7.

APPOINTMENTS AND SITUATIONS VACANT—contd.

PHARMACOLOGIST J. F. Macfarlan & Co. Ltd. invite applications from graduates in pharmacology or allied sciences for the above position. Applicants should be familiar with modern pharmacological techniques, previous research experience desirable but not essential. This post offers an opportunity for a young worker to join a research team engaged in the search for new drugs. Attractive working conditions are offered. Salary in accordance with qualifications and experience. Applications giving details of age, qualifications, and experience should be sent in writing to the Technical Director, J. F. Macfarlan & Co. Ltd., Abbeyhill Chemical Works, Edinburgh.

CONSULTANTS REQUIRED—Scientists and Engineers located throughout the U.K. required to act as occasional advisers on industrial problems. Send comprehensive, professional details in confidence to Box No. C.479, THE NEW SCIENTIST.

UNIVERSITY OF OXFORD

Electronic officer required in **Pharmacological Laboratory** engaged in research and teaching. Salary according to qualifications and experience. Application to Professor W. D. M. Paton, Department of Pharmacology, South Parks Road, Oxford.

PUBLICATIONS ASSISTANT

The British Cast Iron Research Association invites applications for the post of assistant to the Publications Officer.

Applicants should have experience in:

- (1) Technical writing and sub-editing.
- (2) Preparation of copy for printers, layout and ordering of illustrations.
- (3) Supervision of proofs.

Technical experience should preferably be metallurgical, but the ability to appreciate new ideas and to harmonise copy and layout is more important.

Some knowledge of exhibitions and displays would be an asset.

The Association has a five-day week, contributory pension scheme, and daily transport is available from Birmingham and Redditch.

Applications stating age (between 25 and 35), and experience should be addressed to the Director, The British Cast Iron Research Association, Bordesley Hall, Alvechurch, Birmingham.

TECHNICAL ASSISTANT (male) aged up to 28, required in Chemical Development Department of Company near Cambridge to assist in development of chemical manufacturing processes. Qualifications: O.N.C. in Chemistry (or equivalent) and one year's industrial experience in chemical development, chemical engineering or analytical work, essential. Good condition of employment and prospects, pensionable post. Lodging accommodation arrangeable. Write (Quoting No. 1525) Personnel Manager, Fisons Pest Control Limited, Harston, Cambridge.

THE COLLEGE OF AERONAUTICS

Applicants are invited for the appointment of **TECHNICAL PHOTOGRAPHER** to take charge of a section which uses photography in research, the including high speed cinematography, photomicrography, aerial and colour photography, data recording, and the photography of special subjects, together with the production of visual aids for lecturing. Preference will be given to candidates holding the final examination (scientific) certificate of the Institute of British Photographers. Salary in scale £800 x £25 to £1,000 x £25 to £1,150 p.a. with Local Government superannuation, commencing salary depending upon age, qualifications and experience. Consideration given to housing requirements. Applications giving full particulars and quoting the names of three referees, to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

RESEARCH ASSISTANT needed, full-time or half-time, for work in research or statistical work. Degree or other qualifications required. Salary according to qualifications and experience within the range from about £450 to £600 p.a. Applications, giving details of the names of not more than two referees to the Clerk to the Faculty of Commerce and Social Science, The University, Birmingham 15, by March 31.

PROMISING OPPORTUNITIES

are offered to girls leaving school, and older girls with a liking for physics or mathematics, and aptitude for practical work, to enter an expanding branch of the electronic industry. If this prospect interests you, why not write for an appointment to come along and discuss it with us in more detail? Please quote TO/1.

PERSONNEL OFFICER.

M.O. VALVE CO. LTD.,
BROOK GREEN, HAMMERSMITH, W.6.
(A subsidiary of the G.E.C.)

SLIB Assistant required to answer, from published and other sources, varied enquiries from industrial and research organisations. Experience of enquiry work and knowledge of languages desirable. Starting salary approximately £600 p.a. Good prospects. Apply Director, Adm. 3 Belgrave Square, London, S.W.1.

PHYSIOLOGIST OR CHEMIST FOR SERVICE IN MALAYA

The Research Organisation of a major group of plantation companies operating in Malaya has a vacancy for a physiologist or chemist whose principal duties will be to take charge of the chemical laboratory and of sand culture trials, and to develop and expand existing techniques of foliar analysis and diagnostic physiology. Suitable qualifications would be an Honours Degree in chemistry or botany with suitable post-graduate experience but applicants are also invited from candidates with an Honours Degree who would be willing to undertake a further period of training before proceeding to Malaya.

Initial salary and commission will be at least £2,200 per annum, plus allowances, free accommodation, passages, and provided food.

Applications, giving full details of qualifications, experience, age, etc., should be sent to Box D.693 c/o Streets, 110 Old Broad St., E.C.2.

ASSISTANT PHYSICIST

required for X-Ray diffraction work with a metallurgical bias. Previous experience not essential but applicants should be of HNC or Pass Degree level or be a Grad. Inst. P.

Please write to the

PERSONNEL OFFICER,
FAIRLEY AVIATION LIMITED,
HAYES, MIDDLESEX.

GRADUATE CHEMIST required to supervise laboratory in N.W. London, concerned with technical aspects of products for research. This appointment is within a rapidly expanding group and is of particular interest to ambitious applicants. Experience in colloid chemistry, rheology, polymer technology and foreign languages would be advantageous. Details in confidence to Personnel Manager, Box No. C.477, THE NEW SCIENTIST.

BEDFORD COLLEGE (University of London), Regent's Park, N.W.1. Applications are invited for boys or girls (age 14-21) for posts as **JUNIOR LABORATORY TECHNICIAN** in the Departments of **BOTANY** and **PHYSIOLOGY**, vacant immediately, G.C.E. or Advanced level in relevant subjects desirable. Salary range: £4.15-£7.14s. per week, plus London Weighting. Applications to the Secretary.

JUNIOR TECHNICIANS required in **PHYSIOLOGY** Department (for work with animals) and in **BIOLOGY** Department. Wages £1.15-£1.14s. per week, according to age, plus London Weighting. Apply in writing to the Secretary, **WILLIAMSBETH COLLEGE**, Camden Hill Road, W.8.

TECHNICIAN OR JUNIOR TECHNICIAN required for Metabolic Unit to assist with research on steroid metabolism. Salary £1,615-£1,750. Junior Technician £1,325-£1,417. Apply Secretary, St. Mary's Hospital Medical School, Paddington, W.2.

ELECTRONICS is the great career for the future. For details of openings and Courses (with apparatus) in all branches, write B.I.E.T. (Dept. E.7), London, W.8.

APPOINTMENTS AND SITUATIONS WANTED

7s. per line—Box Number 15, extra.

RESEARCH GLASSBLOWER, 26 years' experience, 16 years at Chief Glassblower in Chemical Research Laboratories, seeks post offering scope for ideas and initiative. Box No. D.65, THE NEW SCIENTIST.

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

7s. per line—Box Number 15, extra.

UNIVERSITY OF LONDON Applications are invited for **IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS** in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology or Physics. The Fellowships will be within the range of £800-£1,000 per annum and will normally be tenable from 1 October 1960 for three years. Family Allowance and F.S.S.U. (if applicable) application forms may be obtained from the Academic Registrar, University of London, Senate House, W.C.1. Applications must be received not later than 30 April 1960.

UNIVERSITY OF LONDON Applications are invited for a **TURNER & NEWMAN RESEARCH FELLOWSHIP** in Engineering, Inorganic Chemistry or Physics. The Fellowship will be within the range of £800-£1,000 per annum and will normally be tenable from 1 October 1960 for three years. Family Allowance and F.S.S.U. (if applicable) application forms may be obtained from the Academic Registrar, University of London, Senate House, W.C.1. Applications must be received not later than 30 April 1960.

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RENUMERATION according to individual circumstances. For J.R.F. £1,150-£1,400 (G.R.F. £800-£1,100 (J.R.F.) Superannuation under F.S.S.U. At expiry of fellowship the holder, if of suitable age, can be considered for an established post. APPLICATION FORMS from the Director, R.R.E., Malvern, Worcestershire, for RETURN by 22nd April, 1960.

THE ROYAL SOCIETY MACKINNON RESEARCH STUDENTSHIP

Applications are invited by the Council of the Royal Society for a **MACKINNON RESEARCH STUDENTSHIP** (for the purpose of furthering original research in the physical sciences, natural history, geophysics, astronomy and engineering sciences).

The appointment is tenable for two years in the first instance from 1 October 1960, but may be renewed for each period as Council may determine. The stipend will be in the range from £50 to £100 depending upon qualifications. There will be superannuation benefits to which the successful candidate will be required to contribute 5% of annual salary. The Royal Society will contribute a sum equivalent to 10% of annual stipend. Children's allowances are payable.

Applications should be made on forms to be obtained from the Assistant Secretary, The Royal Society, Burlington House, London, W.1, and should be received not later than 18 April, 1960.

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS—contd.

UNIVERSITY OF BRISTOL

Department of Organic Chemistry

Applications are invited from qualified candidates for a post-doctoral research fellowship to which an appointment will be made during the current academic year. The successful candidate will work in collaboration with Dr. A. R. Batterby on the chemistry of natural products, particularly in the alkaloid field. The appointment will date from October 1969 or earlier if the selected candidate is available before that date. Salary will depend upon qualifications and experience, but will be within the range £700-£1000 per annum, together with, in an appropriate case, £350, bursary. Applications (1 copy) stating age, details of qualifications and experience, publications and research work in progress, together with the names of two referees, should be received AS SOON AS POSSIBLE by the Registrar. The last date for receipt of applications is 30th April, 1969.

FELLOWSHIP IN ENGINEERING SCIENCE

The College proposes to elect an Official Fellow and Tutor in Engineering Science as from 29 September 1969 and invites applications to be received not later than 23 April, 1969.

The Fellowship may be held jointly with a University appointment. There will shortly be a vacancy for a Departmental Demonstrator in the Department of Engineering.

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Further information may be obtained on application to the REGISTRAR, IMPERIAL COLLEGE, LONDON, S.W.7

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The Department of Scientific and Industrial Research has accepted the Post-graduate Diploma courses in Psychology and Numerical Analysis, and the M.Sc. Advanced Course Studentships. Students intending to read for Higher Degrees in Science by thesis are invited to enquire of the College whether it has available any D.S.I.R. Research Studentships.

Applications for admission to the College should be made before 1 June. Pamphlet and form of application may be obtained from the Registrar, Birkbeck College, Malet Street, W.C.1

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